THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 38. Thursday, March 15, 1928. No. 604.

PUBLISHED WEEKLY

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telephone: Gerrard 3961 (4 lines).
Telegraphic Address: "Zacatecas, Rand, London."

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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

MARCH 20.

Institute of Metals (Birmingham Local Section):—W. B. Ballard on "Non-Ferrous Tubes." (The Paper forms part of a joint programme arranged by the Birmingham Metallurgical Society, the Staffordshire Iron and Steel Institute, and the Birmingham Local Section, Institute of Metals.)

MARCH 21.

Newcomen Society for the Study of the History of Engineering and Technology:—Ordinary general meeting at 17, Fleet Street, E.C.1. "James Sadler: Aeronaut, Engineer, Chemist and Inventor," Paper by J. E. Hodgson.

Institute of British Foundrymen.

MARCH 16.

Middlesbrough Branch:—Ordinary meeting at Cleveland Technical Institute, Middlesbrough. "Foundry Design and Handling," Paper by A. W. Bagshawe, Dunstable.

MARCH 17.

Lancashire Branch (Junior Section):—Ordinary meeting at Manchester. "Mass Production in the Foundry." Paper by W. Yates (winner of the John Wilkinson Medal, 1926).

Scottish Branch (Falkirk Section):—Ordinary meeting at Falkirk. "The Moulding and Casting of Small Pulleys and Gear Blanks," Paper by J. Longden.

Wales and Monmouth Branch:—Ordinary meeting at Newport. "Plaster Work and Plate Moulding," Paper by T. W. Markland.

MARCH 22.

Birmingham, Coventry and West Midlands Branch:—Ordinary meeting at Birmingham. "The Training of Young Foundrymen," Paper by T. Makemson.

Rapprochement.

The topic of the relationship between practical and theoretical men is always with us, but points raised at and subsequent to the recent meeting of the Institute of Metals have given it a fresh fillip. In this connection it seems desirable to us to point out one common cause of misunderstanding.

We have on the one hand the practical man, the employer of labour and the maker of goods for sale, working under all the restrictions of commercial conditions but at the same time enjoying an extraordinarily detailed and intimate knowledge of those conditions as applied to his own particular industry or section of industry. On the other hand there is the highly-trained scientific man, devoting himself to scientific research in the necessarily somewhat cloistered atmosphere of a laboratory. Now, whether the latter—in the present case the scientific metallurgist—be actuated by purely intellectual motives, or whether it be his earnest desire to contribute by means of his work to material prosperity *via* industry—the majority of us are inclined, since we live in a material world, to judge his achievements by their ultimate practical utility. Indeed, he himself frequently claims his work to be important largely in proportion to its practical potentialities, or what he conceives as such.

Now, the question that arises is this: How far can co-operation of a direct nature hope to be established at all as between people of such differing outlook and background? They must be prepared each to recognise the other's importance and qualifications; they must be prepared to learn from one another; but can the one hope to offer the other anything in a fit state for immediate use?

Judging by the views commonly expressed on the subject, the endeavour to establish direct relations is in many cases far from successful, and it seems to us that understanding between the practical man and the theoretical man will increase largely as they come to recognise the need for an intermediary. The one makes the scientific discovery, but lacks the everyday workshop experience and atmosphere without which its practical application cannot be envisaged, much less elaborated; the other has a vast knowledge of practical conditions but is unable sufficiently clearly to comprehend the nature of the scientific discovery to adapt it to meet its own needs. Surely what is needed is an intermediary who has both scientific training and practical knowledge; who is not tied like the scientist to the elucidation of abstract problems or like the "practical man" to the day-to-day exigencies of productive industry. It is for such a man to prepare the work of the one to meet the requirements of the other, to act as a sort of liaison officer between the scientist and the manufacturer, since he speaks both their languages and has for his first task the interpretation of the one to the other.

Here surely lies the peculiar task of industrial research, whether it be in the hands of research associations or of works laboratories and their staffs—to act as interpreters between the scientific and the practical men, where such interpretation is desirable, as indeed we feel it to be in a very large number of cases.

Lessons from Failures.

Mr. John Shaw has favoured us with an advance copy of a paper he is to present in the near future to the Institute of British Foundrymen. In Part 2 of this he deals with the failures of cast iron as set out in the last twelve annual reports of the British Engine, Boiler and Electric Insurance Company. Mr. Shaw is enthusiastic in his praise of the excellence of the reports when dealing with failures due to steel, but laments the lack of fundamental data and detail of those relating to cast iron. There appears to have been too much emphasis given to initial casting strains when the material has been in use, say, a dozen years. Moreover, there are frequent references to bad design. According to Mr. Shaw, however, there are many failures which are undoubtedly due to unsuitable analysis. So far as fatal explosions are concerned, it must be admitted that cast-iron castings show up badly. Some of them should never have been passed originally, as they were badly out of section. Mr. Shaw has drawn up a number of recommendations to both engineer and founder, with the object of reducing these deplorable accidents. To the engineer he gives the following excellent advice:—(1) To place all orders for pressure castings with firms who have instituted a proper system of metallurgical control; (2) to insist on rigid inspection; and (3) *to pay a fair price which will cover the added costs to be associated with adequate control and inspection.* The italics are ours, as we feel that if this last consideration is met, troubles, breakdowns and casualties will be reduced to a minimum.

For the founder, Mr. Shaw has the following suggestions:—(1) If reputation is of importance, then it behoves the founder himself to institute rigid inspection, especially when used in connection with steam, oil or gas, even though it is only a common pipe; (2) suitable mixtures must be incorporated; (3) if normal practice inhibits the use of a special mixture, then either depart from ordinary practice, and if price conditions prevent this, then refuse the order; (4) conduct the foundry in such a manner as to regain and maintain the confidence of the engineer.

We wish to associate ourselves with Mr. Shaw in thanking the author of these valuable annual reports and in assuring the latter that little difficulty is likely to be experienced in obtaining for him the co-operation of the recognised research authorities both here and abroad.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Carron Works.

To the Editor of The Foundry Trade Journal.

Sir,—In "Random Shots" of the 8th inst. "Marksman" refers to Roebuck, one of the founders of Carron Works. It may interest readers to have the following extract from the brochure of the Carron Company issued in 1909, their 150th anniversary.

"The Company largely owes its inception to Dr. John Roebuck, *of Sheffield*, an eminent scientist and mineralogist of his time, and the discoverer of some important improvements in the production of iron.

"Dr. Roebuck, when partner with Samuel Garbett as chemical manufacturers at Prestonpans, near Edinburgh," etc., etc.

Dr. Roebuck died in 1794, and Mr. John Pate, of the Carron Company, informed me, was buried in Carriden Church Yard.—Yours, etc.,

E. Adamson.

18, York Street, Sheffield.
March 12, 1928.

Selections of Pig-Irons.

To the Editor of The Foundry Trades Journal.

Sir,—We have read the admirable and comprehensive article by Mr. Arthur Smith on "The Selection of Pig-Irons" in your issue of March 1, and are in close agreement with him that pig-irons should be bought to specification. Perhaps, however, we may be allowed to comment on the fact that only one suggested specification is put forward for refined irons. This is opposed to one of the main objects of the refinery process and refined irons, which is to produce and supply iron of different specifications to meet the exact requirements of the varying types of high duty castings. For each type of casting there is an ideal specification towards which to aim, and the foundryman looks to refined iron makers for a composition which, either used alone, or mixed with the other irons he has available, will enable him to approach the ideal as near as circumstances permit.—Yours, etc.,

Bradley & Foster, Limited.

Darlaston Blast Furnaces, Darlaston.
March 10, 1928.

Research Developments in Non-Ferrous Metallurgy.

In our last issue we outlined a number of researches presented to the spring meeting of the Institute of Metals. Below is set out the balance:—

THE EFFECT OF QUENCHING AND TEMPERING ON THE MECHANICAL PROPERTIES OF STANDARD SILVER.

By A. L. Norbury, D.Sc. (Birmingham).

Standard silver (92.5 per cent. silver, 7.5 per cent. copper) as ordinarily annealed contains a considerable amount of copper (in which some silver is dissolved), distributed in the form of small particles throughout the silver solid solution matrix. By suitable heating (*e.g.*, about half-an-hour at 770 deg. C.) and quenching, these copper particles may be dissolved and retained in supersaturated solid solution in the silver.

On tempering quenched specimens, structures reminiscent of martensite, troostite, and pearlite are obtained (the as-quenched solid solution structure being similar to austenite). The "martensitic" structure is the hardest and least ductile. The alloy when in the quenched condition is about 30 per cent. softer and 20 to 30 per cent. more ductile than it is when in the as-ordinarily-annealed condition.

On suitable tempering the quenched alloy (*e.g.*, about half an hour at 300 deg. C.) its Brinell hardness increases by about 300 per cent., and its tensile strength by about 50 per cent. At the same time its ductility falls by about 50 per cent. These effects are due to the decomposition of the supersaturated solid solution of copper in silver.

The hardening on tempering is accompanied by a decrease in volume, whilst the hardening obtainable by tempering is uniform, and is consequently superior to the hardening obtainable by rolling, stamping, and similar operations where the hardening is not uniform and sets up stresses and strains in the alloy. It is possible to harden the quenched alloy by cold-work, and then further harden it by suitable tempering.

On cold-working specimens tempered at different temperatures, and consequently of greatly different hardnesses, the specimens tend to become equal in hardness as the amount of deformation is increased. The alloy is more resistant to oxidation and tarnishing when in the quenched and tempered conditions than it is when in the annealed condition.

Appendix.—The removal, by annealing, of coreing in cast cupro-nickel is greatly assisted by deformation before, or during, annealing.

THE INFLUENCE OF DISSOLVED GASES ON THE SOUNDNESS OF 70:30 BRASS INGOTS.

By G. L. Bailey, M.Sc. (Woolwich).

The work described had the object of determining whether unsoundness could be induced in 70: 30 brass ingots by treating the molten metal with various gases before pouring. Preliminary experiments on bronze (an alloy known to be susceptible to gas effects) showed that treatments with nitrogen gave an ingot practical free from unsoundness due to gas. Comparative tests were made on samples of 70: 30 brass treated with nitrogen, hydrogen, and sulphur dioxide, poured in a series of moulds giving different speeds of solidification. No evidence was obtained in any of the treatments of unsoundness in the ingots caused by gas evolution during solidification.

It is concluded that if appreciable amounts of gases are soluble in liquid brass the solubility in the solid state is sufficiently high to retain the gas in solution. The probability is, however, that the high vapour pressure of zinc in molten brass precludes the solution of gas by the alloy.

THE RELATIVE CORRODIBILITIES OF FERROUS AND NON-FERROUS METALS AND ALLOYS.—PART I.—THE RESULTS OF FOUR YEARS' EXPOSURE IN THE BRISTOL CHANNEL.

By J. Newton Friend, D.Sc.

Fifty bars of ferrous and non-ferrous metals were exposed to sea action in the Bristol Channel for four years, and an account is given of the fourteen non-ferrous bars. Losses in weight, depths of pitting, reduction in diameter, and fall in tensile strength in consequence of corrosion are correlated. The metals examined included tin, lead, nickel, zinc, aluminium, and various coppers and brasses. Nickel, tin, and lead resisted corrosion remarkably well. Of the brasses, screw metal (1.37 per cent. lead) made the best showing. This was closely followed by the nickel-copper (1.75 per cent. nickel). A galvanised iron bar lost less in weight than either the iron or the zinc separately. The aluminium bar was very deeply pitted. Dezincification of the brasses is discussed. The relative rates of corrosion of ferrous and non-ferrous metals and alloys are compared.

THE QUENCHING AND TEMPERING OF BRASS, BRONZE, AND "ALUMINIUM-BRONZE."

By Tsutomu Matsuda, Sc.D. (Osaka, Japan).

The effect of quenching and tempering on the microstructure, electrical resistance, hardness, and other mechanical properties of brass, bronze, and "aluminium-bronze" was examined. It was confirmed that these copper alloys containing a proper amount of the second metals may be hardened by suitable heat-treatment.

The nature of the temper-hardening was investigated by means of microscopic and dilatometric tests and electrical resistance measurements, and it was concluded that the hardening is accompanied by the separation of α from β or γ, or the decomposition of β or γ into eutectoid, or both of these changes, and probably due to the straining of space lattice produced by these structural changes.

Random Shots.

In connection with my recent remarks on the history of ironfounding, visitors to the British Industries Fair may have noticed with interest the 150-year-old broadsheet of the Carron Company there on show. It gives a fairly comprehensive idea of the multifarious purposes which iron served a century and a half ago, and leads inevitably to reflection on the changes that have occurred in this respect. . . . Who at that time would have dreamt of the aluminium frying pan or the tool of Sheffield steel?

* * *

Every time I look at an American magazine I am reminded of the old story of the boxing instructor, who asked his very raw pupil if there was anything he wanted to know before the lesson proceeded. "Yes," gasped the novice; "how much is your correspondence course?"

* * *

Of course, even in this benighted country there are a few things that we can learn to do by post—enough to keep most of our evenings pleasantly and variously occupied should we so desire. As, for instance, writing stories, learning how to treble our income, playing jazz instruments, making Paris gowns, and so forth. . . . But when it comes to a comparison with our brethren on the other side we seem to lack something in imagination.

* * *

No American, for instance, would be content to study a course that undertook to multiply his income by less than five. In addition he can learn to speak and write correct and fluent English (one wonders about the nationality of the compiler of this course); he can buy his culture ready potted in doses just suited to his capacity, and he can also learn the secret of personal magnetism—and after that, what is there left to desire?

* * *

The ladies are even better catered for. I was always especially attracted by the advertisement that offered to transform "a demure little wren of a girl" into a "Bird of Paradise woman overnight," so that she might win "the husband of her dreams." . . . While many of us might be glad to pass on a "course on dietetics that teaches the secret of keeping a happy husband." . . . Postal instruction in the retention of that youthful figure may also be obtained, and no doubt the art of laying a table appeals to the budding waiter.

* * *

Marksman's Little Tales of Success.

No. 3.—Ferdinand Forward.

For many years Ferdinand had been a foreman in a flourishing foundry, but lately he had begun to suspect that his hand had lost its cunning. No longer did his men spring to obey him with alacrity, no longer was he able by a flicker of the eyelid or a gesture of the hand to secure attention for his slightest wish. For long he pondered—had his tongue lost its vivid variety, for which he had long been famous throughout the district? In desperation he sent for a much-advertised correspondence course on "How to Lead Men." Earnestly he studied the first maxim that the book contained—"Remember that good manners and polite language are of prime importance—no order is too trivial, no instruction too petty to be delivered without care in choice of words and modulation of voice . . ." Alas! things went from bad to worse. Frantically Ferdinand sent for another correspondence course—this time entitled, "How to have an Endless Flow of Words Always at your Command." It was no use. His men were thoroughly out of hand. The grim spectre of the labour exchange haunted his dreams. . . . And then the manager sent for him.

Ferdinand is now sales manager, earning seven times his previous salary. Furthermore, he now gets his hair cut in the firm's time.

Marksman.

New Gas-Fired and Oil-Fired Furnaces.

In the course of a Paper read before the Birmingham Association of Mechanical Engineers recently, MR. JOHN FALLON, of The Incandescent Heat Company, Limited, gave some particulars (with illustrations) of several new types of gas-fired furnaces designed for specific service. In some preliminary remarks on heat generation he submitted the subjoined table (Table I), showing the comparative heat content of various fuels as purchased per 1d. of expenditure.

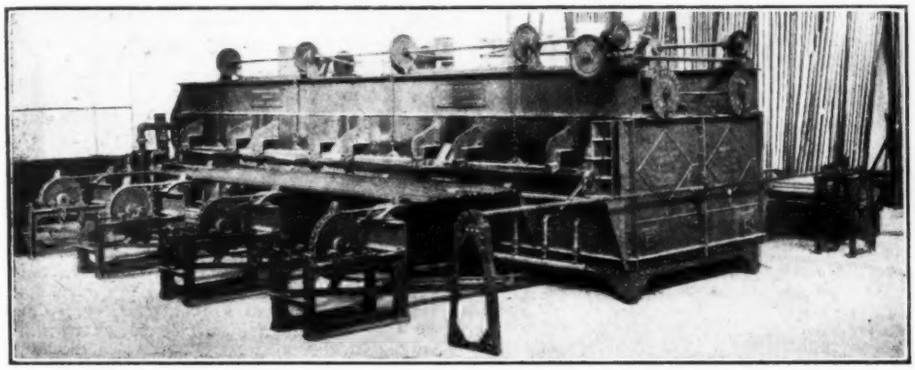

FIG. 1.—CHARGING SIDE OF A TOWN-GAS-FIRED FURNACE.

TABLE I.—*Comparative Heat Content of Various Fuels, as Purchased per 1d. of Expenditure.*

	Fuel.	Basis cost per ton.	Calorific value per lb. in B.T.U.	B.T.U. in fuel received per 1d.	Percentage of heat per 1d. Coal=100 per cent.
		s. d.			
1	Coal ..	20 0	13,000	121,000	100
2	Coke ..	29 6	12,000	76,000	62.8
3	Oil ..	90 0	18,900	39,120	32.3
4	Town gas	2 6 per 1,000 cub. ft.	475 per cub. ft.	15,800	13
5	Electricity	1d. per kw.-hr.	3,411 per kw.-hr.	3,411	2.82

Fig. 1 shows the charging side of a town-gas-fired furnace having a hearth area 20 ft. long × 4 ft. wide. This furnace is of the suspended-crown type and is installed for the annealing and heat-treatment of solid-drawn seamless tubes in mild, carbon and alloy steels, principally in connection with aircraft manufacture.

The common practice of dealing with tubes, bars or other work in length by the end-charging method has many disadvantages—the entire hearth area cannot be fully utilised, and in the process of discharging, tubes and such sections are frequently bent and distorted. The suspended-crown furnace is an example of adapting the furnace to the work instead of the work to the furnace. Its introduction has effected substantial savings in labour and fuel. The charging conveyor consists of four nichrome detachable link chains operated by hand power. In some instances this form of conveyor may be fitted with power drive or substituted by a light form of charging machine.

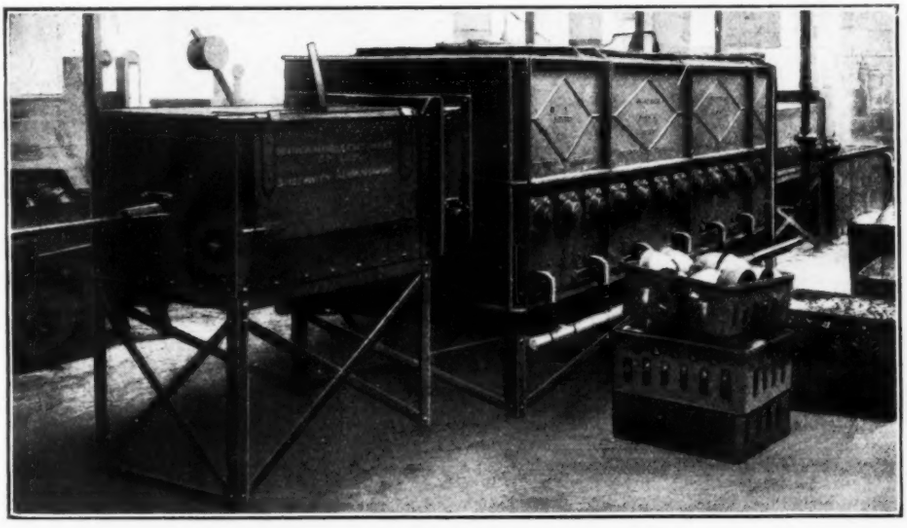

FIG. 2.—CONTINUOUS LIVE-ROLLER-TYPE ANNEALING MACHINE.

Fig. 2 shows a general view of a continuous live-roller-type annealing machine, incorporating a totally-enclosed, radiant-heat, town-gas-fired natural-draft furnace. This plant is installed in a local works for bright-annealing miscellaneous brass and other non-ferrous pressings, and most satisfactory results are being obtained. The pressings are placed in perforated steel baskets, as shown in the foreground, and charged through the door opening at the side of the small charging chamber; they are then passed continuously through the furnace section, the cooling chamber, and finally through a sealed shute into a water bosh or quenching tank. A superheated steam atmosphere is maintained throughout the entire cycle of heating and cooling.

The pressings, when annealed, are quite clean and free from oxidation or discoloration, and pickling or other auxiliary cleaning processes are as a consequence dispensed with. This plant displaced five semi-muffle furnaces in which the pressings during annealing were exposed to the products of combustion, with resultant oxidation, involving loss of metal and labour and expense of pickling.

Fig. 3 shows a 50-ft. producer-gas-fired, ten-hole wire-patenting furnace with self-contained producer, suitable for patenting or annealing carbon- and mild-steel wires. The holes referred to are continuous muffle tubes made up of sectional fireclay blocks supported on a silica arch. The principle involved in the patenting of carbon-steel wire is that of obtaining a sorbitic structure by rapid cooling in the atmosphere, or with heavy gauges by cooling in air blast or a lead bath.

The gases passing from the producer are discharged into a combustion chamber and have uniflow travel with the wire. After passing through the combustion chamber the gases circulate over the top of the tubes and thence through a continuous contra-recuperator in which the air required for combustion is pre-heated.

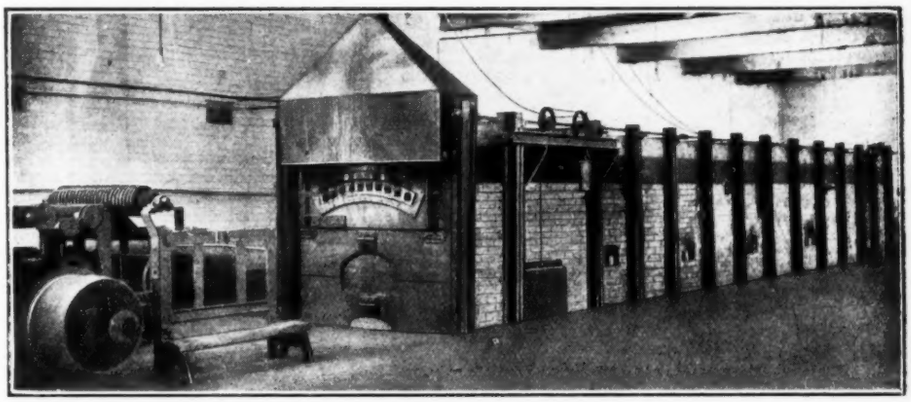

FIG. 3.—PRODUCER-GAS-FIRED WIRE PATENTING FURNACE.

In continuous-type furnaces, such as billet-heating, etc., the contra-flow principle is usually followed, but in wire patenting the material must be heated as rapidly as possible to a predetermined temperature and the necessary time element allowed for soaking and diffusion.

The uniflow principle enables this cycle to be followed at varying capacities with much greater precision. A temperature of approximately 950 deg. C., is maintained inside the tubes, which are purged with producer or other inert gas. This system of purging has reduced scale losses from 6 per cent. to 0.75 per cent. of the weight of wire treated, a consideration ranking equally with that of fuel cost.

The consumption of coal with this process ranges from 2¼ to 3 cwts. per ton of wire treated. The output of the furnace is 10 cwts. of wire per hour; 84 tons per week for patenting with from 40 per cent to 50 per cent. increase for annealing.

Oil-Fired Furnaces.

Fig. 4 shows the charging end of a new type of oil-fired billet-heating furnace, which has given remarkable results in regard to capacity,

uniformity of treatment and economy in connection with billet heating in the non-ferrous industry. Outputs ranging up to four times those obtained from producer-gas-fired, coal-fired, and other types of furnaces are reached with this system in leading extruding works. A large number of these furnaces is now at work in the Midland area.

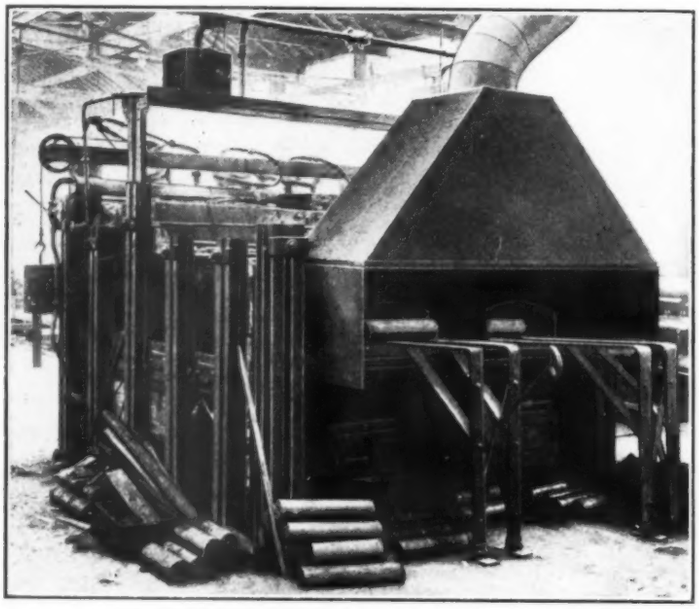

Fig. 4.—Charging End of Oil-fired Billet-heating Furnace.

For heating brass billets for extruding, fuel consumptions as low as 30 lbs. or 3.25 galls. of oil per ton of billets heated are regularly obtained in practice.

The old principle in continuous billet heating wherein the whole of the gases are delivered to the discharge end of the furnace has been abandoned. The main heating of the billets is accomplished by end-and-side heating on the semi-muffle principle, thus giving the necessary time element for thorough soaking. The gases delivered at the discharge end are merely used for the purpose of balancing the temperature and obtaining final temperatures within the critical limits desired without punishment or severe cutting action and oxidation of the billet surfaces.

Furnaces of this type are relatively low in first cost, economical in floor space, and some idea of the capacity may be obtained from the fact that a twin-chamber furnace, such as that shown, each chamber 8 ft. long × 2 ft. 6 in. wide, will give a total output of 4 to 5 tons per hour. This furnace may be operated at full working capacity within 30 mins. from starting up from cold.

The application of oil-firing to galvanising in the sheet and wire industry is of considerable interest. In a bath 5 ft. 10 in. square × 3 ft. 9 in. deep, to which oil-firing has been applied, the output, when dealing with 24-gauge sheets with a back-end temperature of 420 deg. C., has been increased from 13 tons to 20 tons per shift, with close control of temperature and an oil consumption of approximately 33 lbs. or 3¼ galls. per ton of finished sheets. Hand-firing operations are eliminated; the men are thus enabled to concentrate their efforts on the actual production, and the bath generally is operated automatically as an integral part of the galvanising machine.

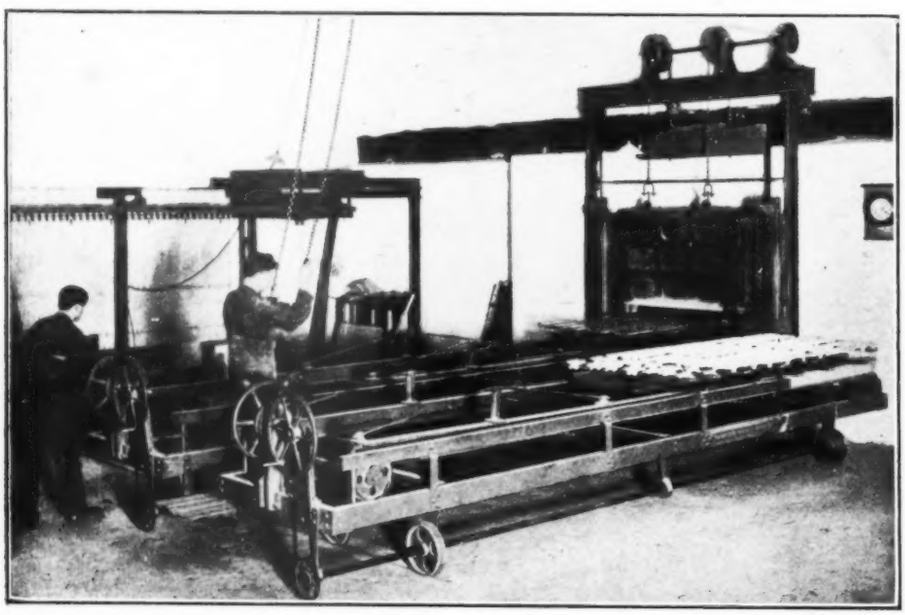

Fig. 5.—Enamelling Furnace.

Fig. 5 shows the application of oil-firing to the vitreous enamelling industry. This furnace is one of a number installed in a leading enamelling works, displacing solid-fuel furnaces. The double-charging machine will be noticed. This enables the operator to withdraw a finished load from the furnace and immediately charge a new load without waste of time. The application of special handling machinery of this type contributes in a large measure to the overall efficiency of the plant. This furnace is fitted with a carborundum muffle, and any desired temperature may be obtained and accurately controlled to within a limit of 5 deg. C.

The oil-preheating tank and automatic cut-off valve, which cuts off the oil supply in the event of failure of the air blast, are features of this furnace. The system is equipped with oil meter, and in some instances these furnaces are fitted with temperature control of the automatic electric type. In this particular instance there is one automatic feature of which mention should be made—the overflow from the gravity tank is placed immediately over the pump-operating valve, and directly over the head of the operator, so that should any incident arise which may distract him from his immediate duty, the overflow discharge, of which he receives the benefit, acts as an effective reminder that the particular job in hand is completed.

The size of the chamber of this furnace is 12 ft. × 4 ft. 6 in. × 3 ft., and the oil consumption at a temperature of 700 deg. C., under working conditions, averages 4½ galls., or 42.5 lbs. per hour.

Condition of Steel Main after Long Service.

The accompanying illustration of a portion of steel pipe is from a photograph which has not been retouched in any way. It represents a section of steel main which was underground for 20 years and which showed no signs of corrosion when dug up. The sample is in the possession of the Bromford Tube Company, Limited, of Birmingham, who put forward the following claims in favour of steel mains:—(1) They are lighter, more economical, and ensure better service than cast-iron; (2) fewer joints are necessary owing to the longer lengths provided; (3) there is less risk of fracture, consequently the all-steel main can be laid nearer the surface; (4) it is easily bent on site, avoiding the ordering of "specials"; and (5) a big saving is effected in leakages owing to the fact that there are fewer joints and that steel is practically unbreakable and therefore leakproof.

Condition of Steel Pipe after being buried for 20 years.

Mr. C. McManus, of Messrs. Major Robinson & Company, Limited, of Manchester, last Thursday, had the honour of being presented to the King at His Majesty's second levée in recognition of his work as a captain in the Territorial Force.

Foundry Purchasing.—XXII.

By Eric N. Simons.

In preventing incessant requisitioning, much will depend, so far as the departments are concerned, on the class of commodities. Naturally, it is impossible to forecast or foresee the need for certain goods. An engineer, for example, cannot prophesy just when a shaft or bearing is going to require replacement. A works clerk, on the other hand, *can* tell with some accuracy when he is likely to need a new order book or cost book. A foundry manager can, by consulting his orders, estimate his requirements in raw materials at least two weeks ahead, and probably more. While, therefore, the engineer has to requisition as and when occasion arises, the others could, without great difficulty, estimate their needs at fixed intervals without in any way disorganising their work. This requisitioning at stated periods should be encouraged by the buyer. It enables him to gauge more accurately the aggregate quantities required in a given period; helps him to estimate the actual quantities being used, and simplifies his office work considerably. Departments should requisition for their requirements in standard commodities regularly, not intermittently. For example, once a week, or once a fortnight, or, if possible, once a month. Apart from the advantages to the buying department of receiving these regular requisitions, there is an advantage to the requisitioning department, which has a proper routine, and so takes stock of its requirements periodically instead of casually. Sudden shortages, desperate emergencies, and all the ills they bring in their train, are thus avoided, and production runs less risk of being interrupted at a vital moment. Larger orders are handled by the buyer, who can obtain better terms as a natural result; and there is a saving in traffic charges on bulk lots.

Preventing Waste of Stationery Stock.

The subject of waste, as it affects the commodities supplied by the purchasing department to the producing departments, does not come within the purview of this series, being essentially a matter of foundry management. But the stationery stock is so obviously an office matter, and so intimately bound up with the purchasing department, that no apology need be made for commenting here on the waste that takes place in many offices, and on how it can be prevented by action on the buyer's part.

The ordinary office employee is careless and wasteful, especially when young. He will send notes into the works written on best letter paper. He will use a large memorandum form when a smaller one would suffice. He will throw away a pencil when it is less than four inches long. He will use stationery as an effective missile when crumpled into a ball. This does not exhaust the number of his misdeeds. He will send a requisition to the stockroom for more paper than he needs to use in a month, and, in consequence, valuable stationery will lie about accumulating dust, much of it having eventually to be destroyed. If a shorthand typist, he will destroy an envelope rather than erase a mistake. And in countless ways he will refrain from taking just that little extra trouble that means pounds saved at the end of the financial year.

It is not the writer's intention to suggest that this waste is deliberate, or even so very prevalent as might appear from his remarks. But it does exist on a sufficiently large scale to make its elimination a matter of importance, particularly in these impoverished times.

The root of the evil is a belief, strong in proportion to the size of the establishment, that "the firm is rich," and that when the company's capital runs into thousands or hundreds of thousands of pounds, little things of this sort do not matter. The simpler a superstition, the more difficult it is to eradicate, and this is true of the instance under discussion. To use the argument: "You wouldn't do it with your own things," is useless. The culprit realises that quite well, but he cannot appreciate that a thing he cannot afford to do with his own possessions is a thing that his employers cannot afford to let him do with theirs.

Only when minor employees become responsible members of the management do they begin to perceive the meaning of large-scale waste. Everyone cannot, of course, attain the manager's desk, and the problem has to be faced. Some firms adopt what may be called the parsimonious method. Everything is doled out grudgingly. As surly an official as possible is put in charge of the office requisites, and when a pen-nib is needed, the clerk has to present himself meekly and petition for it in person.

Naturally, men with any backbone in them chafe against this method. They quarrel with the stock-room clerk, who, in revenge, cultivates an irritating habit of reporting them for incivility or bad language. Much time is wasted in futile inquiries into these charges.

The one satisfactory way out of the difficulty is to throw a greater burden of responsibility on the departmental managers. It is quite possible to work out figures showing just how much or how many of any particular class of stationery supplies is likely to be needed by the staff during a certain length of time. Take pencils, for instance. One pencil a man for a fortnight is a quite reasonable allowance. Two pencils a man is generous. Assuming an office staff of fifty, this should allow, splitting the difference, a weekly distribution of 38 pencils.

The general office, containing, let us say, a staff of ten clerks, should require, as its share of the allotment, 12 or 13 pencils a week. On the Monday of each week the official storekeeper would send this quantity to the general office manager, together, of course, with his share of all other office stationery. It would then be the latter's task to supervise its distribution among his subordinates, or to arrange for this to be done. Any surplus at the end of the week would be returned automatically to the store-room (*i.e.*, the stockkeeper would be notified of the exact amount of the surplus, which he would deduct from the next week's allotment when issuing further supplies). Any deficit would have to be explained by those responsible. A careful account of departmental surpluses and deficits would be kept in the buying department, and an examination of the figures would not only reveal the greatest culprits, but also win recognition for the economical.

It must be clearly understood that allotment schemes of this sort can only be carried out with commodities and supplies regularly used in quantities that do not fluctuate greatly over a twelve-month, such as riddles, shovels, brushes, etc. This applies also to periodical requisitioning, which, obviously, could not be observed in all cases.

Mr. Hinkler's Flight to Australia.

It is interesting to note that the castings of the Cirrus engine used by Mr. Hinkler in his successful flight to Australia were cast in Coventry, the heart of the British motor industry, and the following cablegram has been received from Mr. Hinkler:—"Bundaberg. To Sterling Metals, Limited, Coventry, England. Would like congratulate you on excellence of aluminium castings supplied by you for Cirrus engine.—Hinkler."

We understand that castings used in the Napier engine with which Lieut. Webster won the Schneider Trophy were also cast in this Coventry foundry.

Cast-Iron Pipes.—The Stanton Ironworks Company, Limited, stock lists for March are now available. Both sand-cast and spun are detailed.

Some Applications of Nickel.

In connection with their exhibit at the British Industries Fair (Birmingham), the Bureau of Information on Nickel, Limited, issued an interesting pamphlet, entitled "Some Applications of Nickel and Nickel Alloys." A section devoted to nickel steels points out that since the war, and particularly since 1922, the use of nickel steels for general industrial purposes has grown rapidly and in many different fields. One of the largest of these to-day is, of course, the automobile. The parts usually made of nickel steel are transmission and rear-axle gears, rear-axle shafts, steering knuckles, stressed bolts, connecting rods, crank shafts, front axles and other components. The advantages in point of dynamic and fatigue strength and toughness of the nickel-bearing steels for these purposes are well known.

Case Hardened Gear Steel.

One of the recent developments in automobile construction is the increased use of 5-per cent. nickel steel for case-hardened gears by reason of the ease of its handling and treatment, its high strength and resistance to impact and, what is most important, because of its superior resistance to wear. This latter quality is probably due partly to its high hardness, but more particularly to its high fatigue resistance.

Another recent development touching the automobile industry is the use of a nickel-molybdenum steel for case-hardened roller bearings, displacing particularly chromium steel. This new steel contains about 1½ per cent. nickel and 0.25 per cent. molybdenum, and in spite of its greater price is proving more economical because of the greater uniformity and dependability of the steel and the ease with which it may be made into bearings.

Altogether there are about a dozen type compositions of nickel-bearing structural alloy steels in commercial use to-day. Generally speaking, they are used either because of superior static dynamic or fatigue strength, or because of increased resistance to wear. It is not possible to discuss these many applications of nickel steels in any detail. Some of the more recent of them are, however, worth individual mention.

New Uses for Nickel Steel.

Although the use of nickel-bearing steels for heavy forgings is one of the oldest general applications, some of the newer instances will be of interest. Turbine reduction-gear forgings, large turbine rotors, die-blocks and hydraulic-press columns are being made of nickel-bearing steels. Increased use is being made of chromium-nickel steel die-blocks in the hot-forging of steel. With such blocks it is possible to obtain over twice as many forgings as with the usual carbon block, and in addition they do not crack during service.

The use of nickel steel for castings is not new, yet not until recently has there been any considerable commercial development of their use for this purpose. Both the strength and the resistance to wear of steel castings are increased by the addition of nickel or suitable combination of nickel and chromium, and for both of these reasons these additions are justified; in rack-and-pinion gears; in high-pressure steam valves, and in rolls because of increased strength; in special track work; in gears; in tractor shoes because of increased wear resistance, etc.

Use in Locomotive Construction.

Another recent development is the use of nickel steels by the Canadian railways, principally so far in locomotive construction. Rod forgings of nickel steels as well as nickel-steel cast frames have been incorporated in some of the recently-built Canadian locomotives. The nickel-steel locomotive stay-bolt is also making considerable headway. Comparative tests of 3 per cent. nickel stay-bolt steel and of iron have shown that the former has 15 per cent. greater strength and 30 per cent. greater ductility. Some of the present developments appear to lend encouragement to the belief that the railways may follow the lead of the automobile industry in utilising in their design and construction the superior properties of the nickel and other alloy steels.

D

Father of the Iron Trade.

BICENTENARY OF GREAT INDUSTRIAL FIGURE.

By T. B. Fowler.

No man, it is safe to say, contributed more to the great industrial development attendant upon the improvement of the processes of manufacturing iron than John Wilkinson, whose bicentenary occurs this year.

Justly called "The Great Ironmaster," says Smiles, and "The Father of the Iron Trade," standing head and shoulders above the majority of his contemporaries in mechanical acumen and practical inventiveness, he was beyond all question one of the most conspicuous industrial figures of his day.

He was closely linked to Birmingham by family as well as by business associations. His sister, Mary, was the wife of Dr. Joseph Priestley, the famous scientist, and it is recorded as one of the redeeming features of an adamantine character, relieved by few glimpses of human softness, that when Priestley's property was destroyed in the Birmingham riots, Wilkinson came forward with substantial assistance for his brother-in-law. For upwards of twenty years he was identified with the growth of Boulton and Watt's engineering business at Soho. He not only contributed castings of a better quality than could be obtained elsewhere, but it was his discovery of an improved apparatus for boring cylinders that helped Watt to overcome the final difficulties that had prevented him from perfecting his invention.

Neighbours' Prophecies.

Never throughout his life had Wilkinson any profound respect for orthodoxy. The very circumstances of his birth at Clifton, Cumberland, in 1728 were unusual. His father, Isaac Wilkinson, himself a skilled ironworker of keen discernment, at the time kept a small farm, and John was actually born in a common market cart used by his mother for taking the produce to a neighbouring market. The event, we are told, caused no little sensation among the simple-minded people of the locality, and more than one prophetically said that "John sum tyme wod bee a girt man."

Schooled first in the academy of Dr. Caleb Rotherham, at Kendal, and later in the forges of his father at Blackbarrow, near Furness, and at Wilson House, near Lindale, in Cartmel, Wilkinson, when little more than twenty, following the failure of his father's last venture, set out to make a business career for himself.

He found employment at Wolverhampton. Then he became manager for the New Willey Company at Broseley, near Coalbrookdale. Full of eager ambition, thrustful and charged with dynamic energy, a grim, determined man who made light of obstacles, he had by 1763 gained sole control of the works. Seven years later he set up a furnace at Bradley, near Bilston, and almost simultaneously he and his brother, William, secured possession of the Bersham works, near Wrexham.

The incessant wars of the peried stimulated the demand for ordnance, and Wilkinson's discovery of a new method of boring cast-iron cannon, ensuring greater accuracy and effectiveness, enabled him to outrival all his competitors. Orders for howitzers, mortars, swivels and shells poured in, and the works were kept going at top speed.

"An Eminent Caster."

The furnace at Bradley had just been established when Watt's friend, Small, heard of "an eminent caster" (Wilkinson) who had "settled during the summer at Bilston," and it was out of the communications then exchanged that Wilkinson's relationships with the inventor of the steam engine originated.

Wilkinson's restless temperament was expressed in repeated experiments. He anticipated James Beaumont Neilson, the Scottish gas engineer, in exploring the possibilities of the "hot-blast" for smelting the ore and producing the pig-iron. It is exactly a hundred years since Neilson took out his patent for heating the blast by passing it through pipes exposed to the flames of subsidiary furnaces before its entry into the smelting furnace. Long before, Wilkinson had experimented at Bradley with a leather "gooseneck," which connected a blast furnace with a cylinder in which the blast was heated. But as the leather was charred and rendered useless, he abandoned the idea, when the substitution of a metal for a leather connection would have solved the difficulty.

Against this failure, however, are to be set many practical achievements of the greatest value. He first applied mineral coal to the smelting and puddling of iron ore in Staffordshire in place of wood charcoal; he was one of the first to use the engines supplied from Soho, applying them to the blowing of improved bellows at a new forge at Broseley; he was chiefly instrumental in casting the parts for the first iron bridge in the country, that over the Severn between Madeley and Broseley; he built the first large steam engine in France for the waterworks at Paris; he brought out a patent for making lead pipe; he harnessed steam to the tilt hammer and the threshing machine; and he built the first iron barge to carry castings down the Severn from his works at Coalbrookdale.

Relentless Character.

The latter innovation seems to have afforded him particular satisfaction. When the boat was successfully launched he wrote: "It answers to my expectations, and it has convinced the unbelievers, who were nine hundred and ninety-nine in a thousand."

James Watt thought so highly of the work done at Coalbrookdale that in 1784 he sent his son to study there.

But Wilkinson was at all times a difficult man to work with. He quarrelled bitterly with his brother, of whose growing friendship with the Soho partners he was passionately jealous. Matters were not improved in this respect by the marriage of his brother's daughter to Boulton's son. "His was a dominating, assertive nature, almost titanic in the force of its elemental passions, in its ambitions, its inflated egotism, and its capacity for hatred and revenge," says Thomas S. Ashton in his "Iron and Steel in the Industrial Revolution." "When differences arose, whether with his rivals, with customers or with employees he was relentless in his bitterness and blind to all consequences."

To do him justice he was perfectly conscious of his own deficiencies. "Peace is a most desirable thing," he once wrote to one of his friends, "and the more so to one of my constitution, who cannot be angry by halves. Resentment with me becomes a matter of business and stimulates to action beyond any profit."

It was this hot, overmastering and tempestuous spirit that led to the complete rupture of his relations with Soho. He had conceived quite exaggerated ideas of the indispensability of the part he had played in the perfection of the steam engine, and presuming on this, and upon a concession, granted to him at his own urgent request, to make the all-important "nozzles" at Bersham, he did not scruple to infringe Watt's patents in wholesale and barefaced fashion.

Blow at Soho.

Had genial Matthew Boulton had his way an eleventh-hour peace would have been patched up, but Wilkinson's intractable conduct rendered this impossible, and, like other pirates, he had to pay the penalty. But he never forgot or forgave the humiliation he had suffered. He exhibited his rancour in the closing of the works at Bersham and the dismissal of the employees, thus cutting off the supplies of cylinders for Soho.

Undismayed, Boulton and Watt determined to undertake the casting and boring of their own engine parts, and with the immediate erection of the Smethwick Foundry they entered the ranks of constructive as well as consultant engineers.

Wilkinson combined farming with other interests, and is said to have run a five-hundred acre farm at Brymbo, near Wrexham, with success. To other personal idiosyncrasies he added the reputation of being an atheist and disciple of Tom Paine, and in Staffordshire, Shropshire, and on the Welsh border his fame was sung in many a quaint piece of native doggerel.

He was a profound believer in iron, and as one who helped to lay the foundations of a new era in the industry, there was something entirely fitting in the fact that when he died at Bradley on July 14, 1808, he should be buried in an iron coffin.

The circumstances attending his interment were no less remarkable than those associated with his birth. He was buried four times, and one of the men engaged in the work used to say that he buried John Wilkinson four times and disinterred him thrice. He was first interred at his seat of Castleford, near Ulverston, but his remains found their final resting-place, within the church at Lindale, amidst scenes familiar to him in his youth and early manhood.

[Wilkinson must have travelled abroad considerably, because we have encountered souvenirs of his industry at the works of Schneider et Cie. at Les Creusot, and again at the Decazeville Works (in the very South of France), of the Commentry Fourchambault concern.—Editor.]

Malleable Iron Fittings.

Records showed that iron pipes were first used for conveying coal gas about 100 years ago, and that with their use came the need for various angle and branch fittings, said Mr. H. R. Hiscott at a meeting of the Institution of Heating and Ventilating Engineers, held at Caxton Hall, Westminster, S.W.1, on March 7.

These, he continued, were made from bent tubes or from pieces of plate cut, forged to shape and welded. With the progress of casting methods it was possible to produce a much larger variety of fittings, but owing to the lack of ductility of ordinary grey iron castings, due to the high carbon-content, research was carried out to provide a specially constituted iron for malleablising, in which the carbon was almost wholly "combined." This research on malleable iron took a considerable amount of time, but there exist to-day high-grade malleable iron fittings which can quite safely hold their own within certain limits, which, by reason of their cleanness of finish and accuracy of screwing, strength and other physical properties, are well suited to the engineer's requirements for general use and also heat and pressure.

In his interesting paper Mr. Hiscott gave a general description of the processes through which a malleable iron fitting had to pass between its raw and finished states, including the annealing process on which the malleability of the fitting depends. In the operation of screwing accurate fitting demanded that all outlets should not only be screwed to perfect gauge diameter to make satisfactory joints, but connections made with them should be perfectly square and in line with the fitting. Constant testing during operation was essential to provide fittings which under tensile stress showed from 45,000 to 56,000 lbs. per square inch. On the question of cost they now compared with wrought iron, gas and steam qualities.

Monthly Survey of Current Literature.—At the instance of, and with the aid of the National Federation of Iron and Steel Manufacturers, the Iron and Steel Institute has begun the publication of a monthly Bulletin for the benefit of the members of that Federation. The Bulletin is on the lines of the bibliography in the Institute's annual volumes. Any member of the Iron and Steel Institute can regularly receive the Bulletin at a subscription rate of 20s. a year, payable in advance. Single copies can be supplied at 2s. each. All applications, with remittance, should be sent to the Secretary, Iron and Steel Institute, 28, Victoria Street, Westminster, S.W.1.

Some Experience in Practical Moulding.*

By H. Sutcliffe.

Materials Used in Moulding.

The principal materials used in the various branches of moulding are sands of various kinds, clay, blackings, sawdust, coaldust, and manure, and in some places cow hair.

The material of which the mould is constructed must allow of the passage of air and gases which are generated within it at the time of pouring, but must also be of a sufficiently compact nature to resist the pressure of the liquid metal and to prevent its discharge through the pores. It must be capable of withstanding the very high temperature at which iron is poured without being affected by it, and it must not be of a nature likely to set up any chemical action with the molten metal. It must be easy to part from the casting, and must impart a clean, smooth surface to it.

Sand is superior to all other substances as a material for forming moulds generally, for, in the first place, the hot iron has no chemical action upon it, though certainly it acts upon the matters which it is found necessary to associate with it, viz., blacking and coal; but, secondly, sand acts well as a conducting medium for the air expelled from the space filled by the iron, and for the other gases generated by the action of the heat on the blacking and the coal; and, thirdly, it possesses considerable stickiness when rammed together, sufficient indeed to make it retain its form against the pressure of the molten iron, and, moreover, it is easily made to conform very accurately to the surface of the pattern embedded in it.

The locality of many an important foundry has been determined by the nearness of suitable moulding sand in large quantities, for it is evident that a great deal of the success of the casting operations depends on the selection of the proper moulding sand and upon its preparation for use.

Sands.

The action of moulding sand is physical. Its chemical composition is only useful as a guide to its physical properties. Most impurities lower the fusing points of sand, especially alkalies and iron oxide. Binding power is mainly due to a thin coating of clay on the silica grains; also to the influence of iron oxide. Binding power is increased by adding clay wash, and fortunately clay is very cheap. Some twelve years ago many loads of old sand were taken out of a foundry and clay water was added to it every day for about five or six weeks. This sand was then returned to the foundry, and it worked out very well for making jobbing castings along with a 50 per cent. addition of red rock.

Porosity and openness should increase with the size and thickness of the casting, the gas evolved per sq. ft. of mould surface being greater, whilst the mould is buried deeper in the sand.

Porosity is increased by the sand grains being of a large size; the fine material fills up the spaces between the larger grains. Moisture partially fills the spaces between the grains, and also increases the volume of gas given off.

Clay contains combined water, which when burnt is driven off, and the clay loses all power of adhesion. In its place is left a very fine silt devoid of binding power.

Skin-Dried Sand Moulds.

Skin-dried moulds are those which are rammed up in green sand and then dried skin deep, after being cleaned up and washed with wet blacking. It will be seen that by skin-drying a mould the moisture on the surface or face of the mould is reduced to some extent. Skin-dried moulds often give sounder and much cleaner castings than do green-sand moulds, and when cast do not generate as much steam and gas, and are therefore less liable to give blown or scabbed and dirty castings. There are moulds which it is necessary to skin-dry owing to their intricate and delicate construction. Such moulds are better able to withstand the flow and force of the molten metal in passing down the runner and then over the face of the mould at the time of casting.

Reducing the moisture on the face and walls of a mould also stiffens the green-sand cores, and there is not the same likelihood of particles being washed up from the face and walls of the mould as with green-sand moulds.

Dry-Sand Moulds.

Dry-sand moulds are those which are rammed up in the same way as the ordinary green-sand mould, but are subsequently dried. These moulds should be vented to a certain extent in exactly the same way as green-sand moulds, for although there is no moisture to expel or force through the walls of the mould, there is always a certain amount of gas generated in the sand at the time of casting, which will pass and escape through the vents without any marked effect. When not vented, sometimes these moulds explode or their gases ignite before the pouring or casting is finished, and the shock causes the face or top of the mould to suffer by small pieces being shaken off, the result being a dirty and unsatisfactory casting, only fit, perhaps, for the scrap heap.

Loam Moulding.

There is little in common between sand and loam moulding, except that each method forms a mould that will hold molten iron and turn out a satisfactory casting. A loam moulder's daily routine is concerned with spindle plates, bricks, straightedges and square strickling boards, strickles, etc., whilst the sand moulder is concerned with various kinds of patterns.

When making a casting in loam, whether large or small, plain or complicated, the preparation of the tackle is most important, and if the casting is a difficult or intricate one, there is more reason for forethought by draughtsman, patternmaker and moulder at this point. The work is laid out full size, as far as is necessary in the pattern shop, and the moulder, with the aid of the patternmaker, procures the dimensions for his tackle from it. The important points for the moulder to control in this matter, apart from the correctness of size, is, first, that the tackle is sufficiently strong; second, that provision is made for runners and risers, bolting up, and escape of air; third, provision for easing or liberating after pouring, and for the contraction of the casting. It is far preferable for a moulder to err, within reason, on the heavy rather than on the light side when making his tackle, because the breaking or snapping of a plate, binder, staple or bolt often means commencing afresh, besides the possibility of injuries to those near the work.

It is now proposed to outline a number of typical jobs recently made, which might have been produced by either the dry sand or loam method. This matter is treated from a jobbing foundry point of view, and it is not claimed that these methods are in any way superior or even as good as might be possible if made in a foundry specially equipped for one class of work.

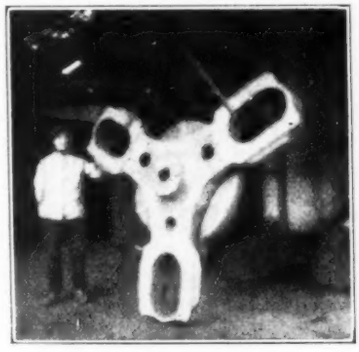

Fig. 1.

Fig. 2.

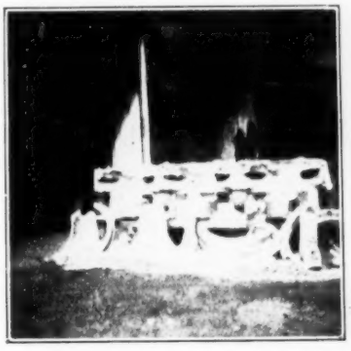

Fig. 3.

The best way to make some of the castings for quick delivery and good results has been borne in mind. It must be remembered that some of these castings are outside work, so they must be reasonably perfect or they will be returned as scrap. If made for internal consumption, some of the returns would be utilised, but the outside firms want exactly what they order, or will place their orders for castings elsewhere.

Second, delivery must be considered, or the work may be lost on account of failing to deliver orders to time. Sometimes a firm is not tied to a few shillings in the price of castings, if the delivery is good, as they can save the extra money by not having to wait at their works.

Third, when making castings for outside firms, the foundry is always up against competition, so it will pay the foreman, when an order comes in, to ascertain the cost, and if there is no profit on the job, to let it go elsewhere, or report it to his manager, as money can soon be lost in a jobbing shop by estimating jobs at too low a price.

There is also another thing to consider when orders are received and castings are required in a hurry: the hurried jobs are more liable to be defective because such items as the fact that two men cannot make a job, working two a day off one pattern, as quickly as one man can make one per day off the same pattern, are often overlooked. This is often neglected when estimating a price for a job. If it is a rush job and two men have to be put on the job to get the order

* Paper read before the East Midland Branch of the Institute of British Foundrymen, Mr. H. Pemberton presiding.

through, often a matter of 3s. to 5s. in wages alone is lost, and then the profit is lowered to vanishing point.

It is also the foreman's duty to utilise inexpensive but not inferior materials. For instance, a large slotter, or one of the calender cheeks, to be dealt with later, had 30 chaplets 3 or 4 in. sq. top and bottom—that is, 60 in all. This would be no small item if there were four required off the pattern, and ordinary chaplets were used for all four simultaneously.

By fastening the cores according to the author's system there will be required thirty stumps, instead of wooden blocks; thirty studs made in cast-iron; thirty 3-in. sq. w.i. plates; these all being for the bottom half of the mould. The top will require thirty 3-in. or 4-in. sq. w.i. plates and thirty w.i. rods. The rods will answer for all four castings, if ordered sufficiently in advance and cut off close to the casting, when dressed, just allowing for the thickness of the four castings in the top part. All that is required after the first casting are fresh plates and studs. There are many castings in tool, engine and jobbing work where this system will apply, but avoiding steam and machinery castings, as the studs will cause the casting to leak in the steam variety and show up in machinery work similarly to any other stud.

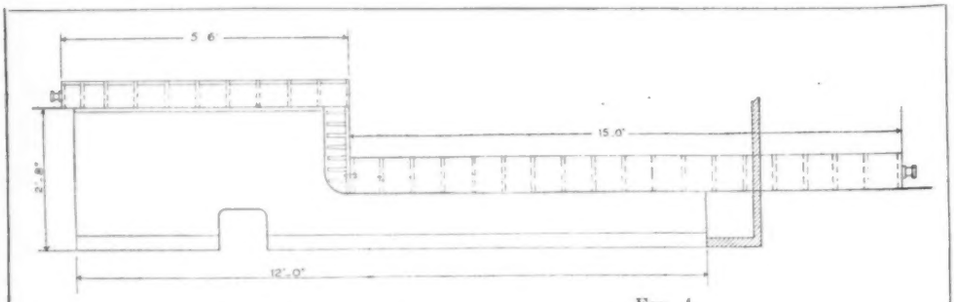

Fig. 4.

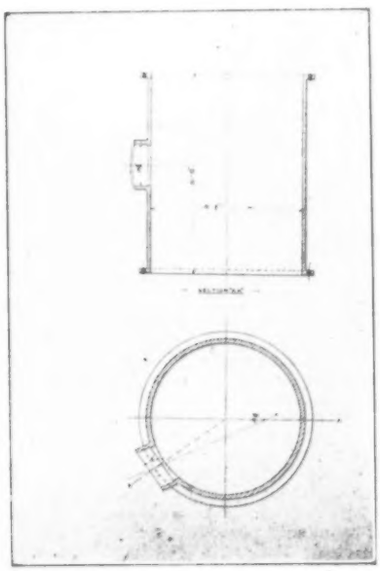

Fig. 5.

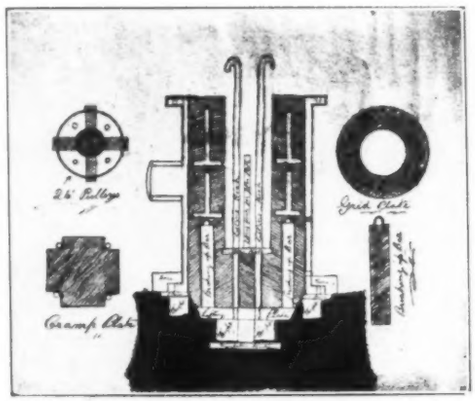

Fig. 6.

Making a Casting in Cores with Top and Bottom in Sand.

When making the casting shown in Fig. 1 in cores with top and bottom in sand, a strickle should be used for both parts, the bottom to form the print and the top to get the depth of the casting, including the boss and the three arms.

As the arms and boss are loose pieces, the boss fits over the spindle in the centre, by which means a quicker method is obtained for making the bed for the cores forming the bottom of the mould (Fig. 2). This centre spindle is also utilised for making the dummy for the top and getting the centre lines for the many things required. The three arms are set by the centre lines on the dummy, and this is how the top part of the casting is placed in the top box.

After the top box has been left off, the bottom should be dug out, and the spindle put in the dandy again in the centre of the box; the bottom strickle should then be fixed on. This is done to delineate the depth of the casting, which is now formed with cores, of which there are forty altogether (Fig. 3). When the cores are in position the vacant places should be rammed up to keep the cores in place. All the cores being in place and having worked to centre lines on the box edge, there need be no fear of the casting being out of shape.

The top box should then be tried on, and note should be taken that the vents of the three round cores that are attached to the three body cores are quite free to pass off, or there will be an explosion if the metal should get into any of these vents, resulting in the production of a bad casting.

The runners and risers should be made up before the top box is put on, and it should be ascertained that the long narrow runner box comes to the moulding box edge, and then there will be better casting facilities provided for the ladle, so eliminating chances of accidents of burning from molten metal going anywhere instead of down the gits of the mould. The weight of the casting is 17 cwt., and the cores were made from gum sand, except the three centre body cores, which were made by the use of "Glyso."

Step Moulding.

The author has carried out this kind of moulding in many shops, and he proposes to exemplify the system by describing the making of a lathe bed, such as shown in Fig. 4, from which it will be noted that there are two flat tops, which eliminate a joint of 18 in. deep. The pronged plate is bolted back to the box end as shown, but if there are no holes in the box, staples should be put in the plate, then a bar put through the staples and behind the box bar, which permits of it being wedged up.

Considerable time can be saved on many jobs in a jobbing shop by using this method. It also creates an economy in lifting power as it eliminates much weight and packing for turning over the box for finishing.

Large Branch Pipes.

Eight of these large branch pipes were made in sand and skin-dried, but one turned out to be a bad casting, so one more had to be made, which brought the total up to nine, Fig. 5.

It is not insisted that the job would not have been better made in loam, but it would not have been as cheap, but apart from this every firm does not employ a loam moulder, as there is not sufficient room in a small shop.

The sketch (Fig. 6) is quite clear. The casting is run from the top, and the branch core spiked back before the body core is put into place. The top flange is formed by segment, and the small square cores are put in to a templet. The bottom flange is formed by a segment core all round, and the body of the casting is rammed up from a pulley rim about 3 ft. deep. This job was a valve tower in a reservoir, and the joints were not machined.

Kier Bottom in Skin-Dried Sand.

This casting is made from a strickle forming a saucer 15 in. deep and 9 ft. diameter, with a flange all round, the top can be made from this. There are five runners in the middle, all 1 in. dia. The four feet on the bottom are set by centre lines, and the boss over the spindle, the cores are put in the flange by templet. This casting is only $\frac{5}{8}$ in. metal.

It should be remembered that castings strain downwards as well as upwards, no matter what weight is on the top part. The mould is wet blacked with a Sheffield mineral blacking, and skin-dried. The blacking is put on with a swab, and the marks are then taken out by a brush. It is assumed that every founder knows that there is a cinder bed under all these kind of jobs, that a cross handle wire is used, and then a needle wire. The only sprigs on this job are a few under the gates. An order for twelve were made in loam and stove-dried.

Top and bottom plates were made with a spindle hole fixed in, so that after the first one was bricked up, the rest of the order, that is the top parts only, required sweeping up with a thin loam after being taken off the casting; the bottom required the feet and boss bedding in again to centre lines, then swept up in the ordinary way.

Prods were provided on the building plates so that the mould was cast above ground, and not rammed up. The strickles were the same, only a fresh one was required for the top. The tackle which would be required when making such a cast in loam would be:—Two plates top and bottom, 9 tons; one building ring, 1 ton; one grid, 7 cwt.; total, 10 tons 7 cwt.; whilst when working with sand only gaggers are needed, and these can be used again.

Holding Cores in Position.

Fig. 7 shows the way how to hold down cores and keep them in their place. The author has repeatedly used this method and found it to be the simplest of all.

Primarily, the taper stump should be knocked down in the solid sand, then the cast-iron stud of the size required for the thickness of metal with the 3-in. sq. plates on top is placed over it; this is all that is required to hold up the core, which should now be held down by the plate and rod. The size and diameter of the rod is determined by the thickness of metal. These rods can be put in the top box before it is tried on, and can be given a tap when the top box is on for the trial which will show just where to put the plates on the top side of the core. It must be noticed that the stalks are flat at both ends to enable them to be scotched up in the same way as an ordinary chaplet.

If the moulder does not use a tube to make a hole for the taper stump, three of these stumps under one core will carry a heavy weight. If he does it takes away the bearing of the weight. Actually the stump should be knocked down in solid sand.

Wheel Moulding Machine Table.

The table shown in Fig. 8 is made from a strickle. The top can be made from a level bed with four centre lines to form a guide for four cores. This particular casting is a wheel moulding machine table for turbine cores, and carrying a dividing apparatus. It is used for dividing the plates in the turbine cores, but can also be used for wheel moulding. A strickle is used for forming the bottom part of the mould, and a core forms the master wheel, the teeth of which are more teeth it would not be a true wheel. As shown in Fig. 9, the mould is on the machine table with the machine arm slung back, but is cast on the floor in green sand. There are two gates on the boss, and two on the rim. The stoppers are lifted from the rim first. This was a very good casting and was also a breakdown job.

Calender Cheek.

In the early part of this Paper reference was made to this casting, which requires 30 chaplets top and bottom (Fig. 10). The casting weighs 4 tons and the metal is run in the foot with 3 in. sq. down gate, and an inlet 3 in. broad, $\frac{7}{8}$ in. thick and 14 in. long. Thre is also a small in-gate at the top of the mould to stop the metal from spinning, as this will drag in the top, if it is not weighting or bolting down is controlled, the result should be good.

The group of castings in Fig. 12 comprise two machine-made bevel wheels, one blank wheel, and one clutch body. These are all green sand jobs. The large wheel is split with parting plates; at one time this gave trouble in getting parting plates to split cleanly, and the firm concerned tried everything in the way of daubing these plates, such as tar, asbestos, red lead and even goat's milk. However, there are still many pulleys and wheels that require splitting, but trouble is never experienced, as the author merely casts the plates, daubs them with thin oil, sprinkles parting sand on them, and dries one side at a time in the stove or over the fire. The wheel blank is also split. The clutch body has sometimes been made in loam, and sometimes in the floor by skin-drying from a

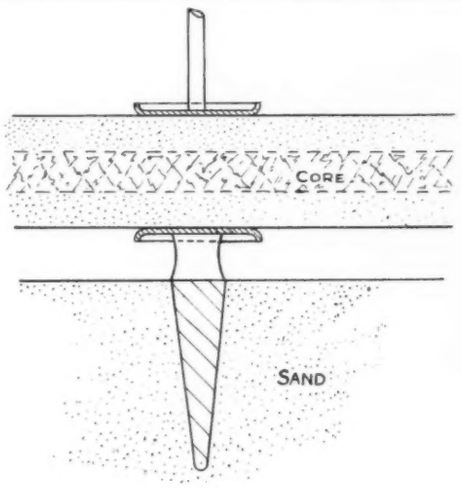

Fig. 7.

Fig. 8.

Fig. 9.

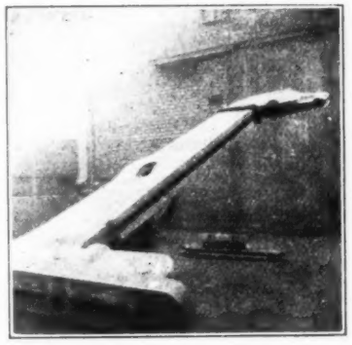

Fig. 10.

Fig. 11.

Fig. 12.

cut $\frac{1}{2}$ in. pitch. Should this part be bad the casting is scrapped, but if it is cast wheel-blank down there is a better chance of it being clean. The machining allowed on the top of the casting is only $\frac{1}{4}$ in. This job is run with three $1\frac{1}{4}$-in. gates in the boss, and two 1-in. gates on the wheel blank, wet blacked and skin-dried. The weight of the casting is 32 cwt., and the diameter is 8 ft.

Internal Wheel.

The internal wheel for the above is made on Jackson & Bros. wheel moulding machine. It is 6 ft. diameter, and is made in male and female box, *i.e.*, top and bottom, and can be moulded at the same time by two men working apart, which saves time on an urgent job. The outside diameter and plate of the wheel in question is formed by strickling. The cross and boss fit on the spindle and are bedded in below the plate of the wheel, and the four cores are put in place by centre lines. The teeth from an internal tooth block with one tooth; if the wheel block had any rammed hard and well gaggered. On account of this casting being 18 ft. long and 10 ft. wide at the foot it had to be covered with two top-parts. The joints between the top boxes of all four castings could hardly be seen when dressed.

The box parts were provided with lugs and flanges, so an overlap grid was made for each box; by this a close sand joint was obtained in the centre of the two boxes. In moulding the bottom a cinder bed is put in, but no hay should be used on top of this, as it serves no useful purpose. The sand should be thrown in the hole and rammed up (Fig. 11).

The pattern should be bedded on black sand, then an inch of facing sand should be laid all over, and the pattern bedded down again on this. This should now be a solid bed. Now ram up the pattern and make the joint in the ordinary way ready for the top parts—one at a time, as a joint on the slant will have to be made on the first one. This joint will govern the putting on of these top parts when finished. Provided the strickled mould, and the small ones from a full pattern in green sand. Poor castings come about by turning them on the side to bear. The result is a crooked boss. Another failure was due to cracking on the plate; whilst a third, which was cast "boss up," was strained on the body and the metal ran out. Now all these mistakes mean starting all over again, and none of them is the result of bad moulding. It is just for the lack of knowledge that they occur.

DISCUSSION.

Mr. Dawson raised a question with respect to running a casting too fast, in which Mr. Sutcliffe said they had literally to team the metal in, what method is applied in the case of it being run too fast whereby the runner bush cannot be kept up.

Mr. Stevenson raised a point with respect to a long cheek casting, with a slide down the inside, which required machining. This casting had been run from one end, a defect in the slide resulting, owing to the distance the metal had to travel, and

the slide being the last to fill up was not a good sound casting.

Mr. Stevenson also spoke with respect to the storing of boxes. His experience was that if boxes for particular jobs were broken up, the job came along again very soon after.

Mr. Freerson, speaking with respect to the cost of coremaking, asked was it not cheaper to make a core in one rather than in sections wherever possible.

Mr. Armitage questioned Mr. Sutcliffe with respect to coal dust in loam, as in his opinion he did not consider it necessary for loam moulds.

Mr. Allamore asked the reason why blacking as well as coal dust was used in the sand mixings.

Mr. Goodwin was not in agreement that it was not possible to make a casting, as shown on lantern slide, of the shape of three broad flat arms with a boss in the centre, when run in the boss, without scabbing, using ordinary green sand.

Author's Reply.

Mr. Sutcliffe, replying to the discussion, expressed the opinion that a mould could not be filled too quickly, and in many instances the quicker the better, especially in the case of a mould with a surface of large area for the metal to flow over before being covered. So long as the runner bush is kept full the mould cannot be run too quickly. Replying to the defective cheek casting, the difficulty was overcome by cutting another small gate or runner at the other end as well as at the end it was run in the first case, resulting in a good sound casting.

The storing of boxes which are made to suit one particular job and are of no use for general work was not advocated. It pays to break them, as the material will earn more in use than standing idle.

It was advisable as far as possible to make boxes which can be used for a variety of jobs, also one end of the box should be left with no projection on, so to allow of one box to be worked close up to another, so facilitating the covering of a mould more easily and effectively.

He (Mr. Sutcliffe) believed in making cores and boxes so to enable the moulder to see clearly what he was doing. As to the question of coal dust and blacking, coal dust not only acts as a medium for the passage of air and gases from the mould, but also forms a film between the face of the mould and outside the casting during the operation of pouring of the metal, assisting the dressing operation by giving a cleaner casting.

With respect to the trouble of scabbing in the three arm casting by using a specially prepared mixing, the trouble of scabbing was eliminated altogether.

Mr. Stevenson moved the best thanks and appreciation for the very able and instructive address he (Mr. Sutcliffe) had given, which was ably seconded by Mr. Bigg.

The Chairman extended to Mr. Sutcliffe the vote of thanks accorded to him.

Obituary.

The death has occurred, following an operation, of Mr. William R. Seward, who for many years occupied an important position in the firm of John I. Thornycroft & Company, Limited.

The death occurred at his residence, 12, Tavistock Road, West Jesmond, on March 6, of Mr. William MacKenzie, in his 53rd year. A native of Castle Douglas, Scotland, Mr. MacKenzie had been for many years representative in the North for McKechnie Bros., of Birmingham, and was well known in shipbuilding and engineering circles.

Sir George Needham, of Oldham, died at Bournemouth on February 29 at the age of 84. The career of Sir George Needham affords a remarkable example of success achieved by industry and perseverance. The son of Mr. William Needham, of Waterhead, Oldham, he was born on November 9, 1843, and went to Oldham High School. A year later he left school and started as a junior clerk with Platt Bros. & Company, makers of textile machinery. By his ability the deceased obtained promotion to more and more responsible positions in the firm. Eventually he was given a seat on the board of directors, and when he received his knighthood in 1920 he had risen to be chairman of the company. Later he retired from the chairmanship and became vice-chairman.

Properties of Blast-Furnace Coke.

Before a meeting of the Coke Oven Managers' Association, held on February 25, at Newcastle-on-Tyne, Mr. J. Curry in the chair, Messrs. W. T. K. Braunholtz, M.A., and H. V. A. Briscoe, D.Sc., read a Paper on the "Correlation of Physical and Chemical Properties of Cokes with Their Value in Metallurgical Processes."

Chaotic Conditions.

Dr. Braunholtz pointed out that it was difficult to obtain a reliable, quantitative comparison of the value of different cokes in blast furnaces owing to the fact that in this country it was unusual for a given furnace to work exclusively on one coke, and partly to variations in the quality of the ore and limestone charged into the furnaces. They were still almost wholly ignorant as to why one coke was more economical than another in the furnace, and blast-furnace managers could give their colleagues at the coke ovens little guidance as to the individual properties most valued. The work described in the Paper was carried out in the laboratory of the Northern Coke Research Committee at Armstrong College, Newcastle, and represented the beginning of an attempt to correlate certain of the more salient properties of cokes with their blast-furnace values.

The bulk sample of several cwts. of each coke was a fair representative sample taken from several ovens over a number of days, and all pieces below 1½-in. were rejected. The coke from the shatter tests was broken to pass a 2-in. sieve, then quartered to about 100 lbs., crushed to pass a 1-in. sieve, and quartered to 25 lbs.; further crushed to pass a ½-in. sieve and quartered to 6 lbs. The 6-lb. sample was crushed to pass a 5-mesh I.M.M. sieve, and was taken to be an average sample of the coke in question. For chemical analysis the average sample was quartered to 150 grammes, and crushed to pass a 60-mesh I.M.M. sieve. The average sample for combustibility tests was obtained from coke discarded during quartering by sieving out of it the fraction 5-10 mesh I.M.M. Its weight averaged about 4 to 5 lbs.

Desirable Physical Properties.

Whilst standard methods existed for the chemical analysis of coke there had been a lack of uniformity amongst furnace managers as to the physical properties desirable. Much of the recent work in the direction of a standard test for reactivity of cokes towards air and carbon dioxide had confused rather than elucidated the main issue—*i.e.*, the influence (if any) of those properties on the behaviour of cokes in metallurgical processes. The shatter test the author considered had approached more nearly to becoming standardised than any other physical method of testing coke. After describing the shatter test he said it was neither able nor claimed to give a complete evaluation of metallurgical cokes. Mechanical strength was admittedly a factor of very great importance in coke, but there were others—uniformity of grading, reactivity to air and carbon dioxide, porous structure—the effects of which could not yet be accurately gauged, and which might ultimately prove just as powerful in affecting the blast-furnace value of cokes and their resistance to impact. At the same time there was no doubt that there existed, in general, a direct relation between the shatter index of coke and its value in metallurgical processes, although isolated cases had been met with in which the shatter test, in its present form, had not given a true evaluation. In such cases it was probable that there were other properties exerting an influence even more pronounced than that of mechanical strength.

Much of the recent criticism of the shatter test seemed to be based on the erroneous belief that the test claimed to give a complete indication of the blast-furnace value of any coke. It certainly did give information as to the mechanical strength of cokes, which was an extremely important property. It was one of the objects of the coke-research committees to determine whether or no there existed a relation between the mechanical strength of cokes and their other salient characteristics. The method adopted had been that laid down by the United States Bureau of Mines, and the results were the average of three successive tests carried out in that manner, excepting that the box from which the coke was dropped was larger (30 in. by 30 in.) instead of 28 in. by 18 in.

Tests showed that the value of the cokes (where known) increased with increasing shatter index, and the quantity of fines caused by dropping, increased with decreasing shatter index, being very high in Cumberland cokes, which were also of a high porosity. In the tests on the influence of weight of sample on shatter-test results, the fact that reliable results were obtainable from three successive tests each with 25 lbs. instead of 50 lbs. of coke, was of considerable value in cases where only a small quantity of coke was available. The influence of the size of the shatter-test box was that the cushioning effect was eliminated, the coke lying in one layer on the plate when dropped. The point was being further investigated as such secondary influences as cushioning of coke pieces should be eliminated.

Reshattered-coke tests showed that it was almost certain that a coke consignment would have a greater index figure at the works after transport than at the coke ovens before loading. Westphalian coke differed from other cokes in that its shatter tests were scarcely affected by repeated shattering, probably due to severer handling in transport, which had made the sample more uniform and resistant. Repeated shattering also tended to diminish the average weights of the pieces of the various fractions.

Combustibility and Reactivity.

Regarding combustibility, the author thought the indiscriminate use of the terms combustibility and reactivity had resulted in confusion and an indifference to experiments published under that head. An apparatus was described which is being used for combustibility experiments. The results showed that the ignition temperatures of all by-product cokes examined (eight) lay between 500 and 560 deg. C.; that of beehive was higher, being 613. The average maximum temperature lay within the range 1,180 and 1,290, with the exception of beehive, which was 1,310. The maximum temperatures showed no relation to the shatter indices of the cokes, as the two extremes in shatter index gave the same maximum temperature.

Describing experiments on specific gravity and apparent porosity of cokes the author concluded there was no marked difference in the true specific gravities of the Cumberland, Durham, S. Yorks. and Westphalian cokes examined. That of South Wales was the lowest. The apparent specific gravity of Durham by-product cokes was higher than that of the Cumberland cokes. The Durham by-product cokes had, therefore, a lower porosity than the Cumberland cokes. In spite of low apparent specific gravities the Durham beehive, South Wales, and Westphalian cokes did not show exceptionally high total porosity. The apparent porosity of the Durham by-product cokes was also rather lower than that of the Cumberland cokes, the percentage of so-called "closed" pore space being higher for the latter.

Continental Steel Trust.

A message from Chalons-sur-Marne states that M. Emile Mayrish, President of the Continental Steel Trust, was killed on Monday night, when the motor-car in which he was riding crashed into a tree. M. Mayrish was one of the leading figures in the steel industry on the Continent and President of the Luxemburg Metallurgical Company.

Herr Fritz Thyssen will, for the time being, take charge of the functions of President of the Trust. Preliminaries have been opened already between the French, Luxemburg and German groups of the Trust as to the election of a new President.

Japanese Import Duty on Iron and Steel.—According to a cabled message from Tokyo, the Bill for increasing the import duty on iron and steel is not to be introduced in the coming spring session of the new Japanese Parliament.

High-Silicon Cast Iron or Acid-Resisting Iron.*

By Ellis Whitaker.

Since the chemical industry began to be seriously established in this country, the subject of high-silicon iron for acid resisting has been an important one, and perhaps to-day we may be advancing, if we have not already advanced, into the iron age, as applied to plant for this industry. For many years past considerable study has been given to the question of acid-resisting cast iron, and it has been one of the most fascinating studies of the metallurgist for the last few years.

To some extent the European War has been responsible for such progress, and a great amount of research work was carried out. Future generations will doubtless be able fully to estimate what an immense amount of improvement has been accomplished during that period alone.

Since necessity is the mother of invention, the dire necessity which arose during the war throughout Europe of obtaining better and more efficient plant to deal with acids, in those days money was more freely expended on metallurgical research, and we owe much to the chemist for his assistance in helping us to find a suitable metal, in the form of iron, which would withstand the corrosive action of sulphuric acid or nitric acid, and long since it has been proved in the laboratory that a pure form of iron could be rendered resistant to either sulphuric or nitric acid, by addition of a suitable proportion of silicon.

It is particularly noteworthy that silicon present in a lesser quantity than 12 per cent. has little or no greater resistance to corrosion of acids than a good ordinary cast iron, whilst on the other hand it has been proved with equal certainty that any excess of silicon over 16 per cent. gives no added resistance to corrosion, consequently in producing these high-silicon irons for resisting acids, one is compelled to work between fairly narrow limits, to preserve the acid-resisting qualities desired, and the graphite carbon content must be at a low figure, about 0.6 per cent. being the limit, if any excess serious difficulties arise in thick sections forming pockets of graphite where two sections of metal join together, and samples are seen from time to time of broken castings, by reason of an excess of graphite in the metal.

Composition Specified.

The phosphorus content must also be restricted to about 0.2 per cent., sulphur about 0.05 per cent., manganese about 0.3 per cent., whilst the best work has been done with silicon at 13 to 15 per cent. A normal average pig-iron may show Si 3.45, S 0.03, P 0.64, Mn 0.66, C.C. 0.27, Gr 3.48 and Fe 91.47 per cent.

To produce an acid-resisting iron it is necessary to get rid of the impurities, and form as pure a form of high grade iron as possible.

The general structure of this high-silicon acid-resisting iron is evidently a solid solution of silicon in the iron, with fairly small graphite nodules uniformly distributed throughout. The contraction of this material is about 3/16ths per foot, whilst ordinary cast iron is 1/10th per foot.

The manufacture of these castings requires craftsmanship of the highest order, and in spite of the success already obtained, there are many difficult factors to be overcome, and all alloys of low-silicon content, under 12 per cent. are attacked very readily by these acids. For condensation of nitric acid high-silicon metal was found a great boon, as plants of large capacity could be constructed very rapidly, which could not have been if pottery were used, owing to the length of time required for its manufacture. In producing these castings in acid-resisting iron, it is a trade somewhat jealously guarded, with the firms who make this class of work, but the author obtained a great amount of practical experience, which was most interesting and at the same time important. This material is largely employed so as to avoid using earthenware sections. The qualities of an acid-resisting material are many and various, and must have sufficient tensile strength to withstand rough usage, and must be proof against cracking owing to sudden changes of temperatures. It must also be machineable and withstand the strain when bolts are tightened at the joints, and of such a nature that the foundry can make castings of desired shapes and sizes, whilst retaining acid-resisting properties which compare favourably with porcelain, which has the highest resistance to corrosive acids.

Factors Influencing Success.

Great care must be given to the melting process, and temperatures of melting and casting should be as even as possible, in some cases casting designs have to be altered, to overcome the difficulties of moulding, and this material is replacing earthenware, owing to the latter cracking with alternate heating and cooling, thus hindering the output.

This metal is a complete success, and the condensed acids are equal in purity to that produced by any other system of condensation. The life of this alloy is practically indefinite as some plants have been in use several years, and are yet doing good work. They have been the means of keeping down maintenance costs, and thus causing a great saving by its long life, compared with other materials previously employed, as plants which were closed down for periods for complete overhaul are now very rarely closed down for repairs since this material was put into use.

It is not thought desirable, however, that reference should be made to its trade name, as it has a world-wide reputation. It melts at 1,200 deg. to 1,300 deg. C., and the loss of silicon is about 0.5 per cent. in the cupola. Great care should be taken to see that the bed is well burnt up before charging, as this facilitates the production of good hot metal at the first tap, and avoids pouring into ingots. As the metal leaves the spout and drops into the waiting ladle or shank, a fluffy layer of shining graphite covers the surface, which is skimmed off. By the time the metal reaches the mould, it is again thickly covered, and this must be skimmed off quickly and the job cast. The material requires to be handled quickly, as graphite precipitates very quickly and soon solidification takes place. For every 1 per cent. of silicon introduced about 0.3 per cent. carbon is thrown out of solution, at or before the moment of solidification, manganese and sulphur in small quantities are regarded as unimportant. The floating kish is sometimes trapped in some types of castings, and thus causes them to leak under pressure. Some of these castings have to be liberated quickly, owing to contraction, as the material is of a fragile nature, and these have to be bared so that cooling should be as even as possible throughout the casting. This is not a happy job for the man in charge, for the following morning he sometimes finds disaster, and learns much by experience. The running of the castings play a great part, the easier the flow of metal the less graphite separation, as when the metal dashes against the core the graphite is violently disturbed and readily freed, and floats around the surface of the casting. This kish cannot be eliminated by skimming, and is always a danger to a weak casting, and many sound castings contain kish somewhere about them which cannot be found except by testing, where the pressure limit is 50 lbs.

Studs should be avoided on cores as much as possible, but if they are used they must be of the same material, or the acid will quickly eat them away. Acid-resisting cast iron has many times the life of stoneware, and a charge of nitric acid takes about 17 hrs. This was usually found to take about 36 hrs. when using a similar condenser built in pottery, thus a greater production can be made from plants installed in acid-resisting cast iron, and the chemical industry have found great advantages, so praise is due to the research workers in guiding the foundry to success in manufacturing this material.

Discussion.

A Member said he understood that acid-resisting iron castings would have to be ground, and not machined.

Mr. Whitaker agreed, and pointed out that they could be machined at a slow rate, and a facing made on them, but they could not be threaded.

Mr. W. H. Poole (Keighley) asked what was the size of the gate as compared with the gate used for an ordinary iron?

Mr. Whitaker said they should be gated with a good down-gate and have a short connection with the runner well up to the casting, so that it could get the feed well through. It required more runners. He gratefully acknowledged that he had received considerable help from Mr. Poole and Mr. Forrest on the technical side of his Paper, and also the loan of some useful lantern slides by Mr. Poole.

Practical Details Desired.

Mr. Poole asked could Mr. Whitaker say whether there was any great difference in practice required in melting these irons as compared with ordinary metal as to blast conditions, the amount of coke required; what particular types of pig-iron were usable; and a little more information as to the actual melting of running metals? Mr. Poole said it seemed to him that in the gating and feeding of these castings there lay the chief factor for success. Another interesting point would be the questions of the best sands to use. He assumed this metal was very hot and rapidly solidified, and handling of it must be quite a fine art. The question of the coating of the mould and the sands would be very interesting. The errosive effect on the mould, he thought, must be something which they did not encounter so much in ordinary work.

Mr. Whitaker said that in some cases it was necessary to skin dry the moulds. Some steel was used in the furnace charge, and sometimes cast-iron scrap containing about 10 or 12 per cent. silicon as a basis. Additionally ferro silicon was added to the cupola charge. This high silicon content was supposed to throw the graphite out of solution to a certain extent.

Kish in the Receiver.

Mr. H. Summersgill said he would like to know whether, in the use of these metals, the graphite had a dirtying effect on the receiver, thereby possibly causing trouble.

Mr. Whitaker said it left a kish behind it, but if there was any trouble it was more in the metal in the ladle, but he agreed that it did soil the receiver a good deal.

Mr. Poole remarked that they were sometimes liable to get this kish effect with an ordinary grey iron when they achieved a very hot melting condition. The higher the silicon content the less was the metal able to hold or retain carbon. The kish thrown out was quite light, and was trapped and sometimes could be seen floating about in the air. He had seen the same phenomenon on blast furnaces. The total amount of the residual graphite would be only about 0.6 or 0.8 per cent.

Bottom Pouring.

Mr. Summersgill asked had Mr. Whitaker any experience in the different methods of pouring this metal, and, if so, had he found any particular advantage in bottom pouring as against lip pouring?

Mr. Whitaker said all the castings were lip poured, and he knew of no advantage to be derived by bottom pouring.

Mr. Poole said bottom pouring from the ladle was done in some foundries, but as regarded the actual casting he thought top running for the mould was better, but from the ladle, bottom pouring might be an advantage.

Mr. Forrest said he thought the violent agitation of the metal would go against bottom pouring.

Mr. Poole replied that for light work he considered lip pouring essential.

Mr. S. W. Wise said Mr. Whitaker must have

* A Paper read before the West Riding of Yorkshire Branch of the Institute of British Foundrymen, Mr. W. Parker presiding.

experienced many difficulties in the use of these irons which one did not have in ordinary cast irons. It would be interesting to know whether Mr. Whitaker had any difficulty with regard to contraction in putting the runner so near to the bar, because it must, Mr. Wise felt sure, be metal of high contraction.

Mr. Whitaker said if they thought the runner was anywhere near the bar they would liberate it as soon as possible or there would be a crack. Moreover, it would be necessary to ease the cores.

Mr. Wise said he assumed this iron was necessarily a low carbon iron, and that the silicon would have a weakening effect on the casting, and there must be a good deal of difficulty in getting the men accustomed to handling it.

Mr. Poole said he was rather surprised to hear Mr. Whitaker say castings from these irons could be machined. In his own experience he had found them very difficult to machine; almost impossible to machine by the ordinary methods.

Mr. Whitaker said much of the work outlined had been machined, but there was no grinding. The lathe, he agreed, had to be run very slowly.

Widening the Foundry Industry.

Mr. A. Jackson, moving a vote of thanks to Mr. Whitaker for his lecture, said that the members had been very fortunate in having such a paper. It was certainly a specialised subject, but it was a subject of importance to all foundrymen, particularly under present conditions in the industry. His own feeling was that in the foundry trade to-day there was not really enough work to go round, and if attention could be drawn to new uses for iron castings it would be doing a real service to the industry—a much better service than the cut-throat competition experienced in the trade to-day. The particular use of this type of acid-resisting casting was, of course, in the chemical industries. The chemical industry generally was enjoying considerable prosperity, and he was convinced there was likely to be an increasing demand in that industry for castings of an acid-resisting character. The acceleration of that demand depended largely on the ability and willingness of foundrymen to produce this special work. The alternative materials to this acid-resisting iron, so far as concerned the chemical industry, were earthenware and porcelain, but neither of those materials could give such good service as cast iron of an acid-resisting quality, which also reduced the time involved in chemical processes and was therefore likely to be more and more in demand. Mr. Jackson said he believed it was in this direction that the salvation of the foundry trade was to be found. He believed it had been found that low temperature carbonisation also could be greatly speeded up by the use of cast-iron retorts instead of the fire-brick or silica brick hitherto in use. To his mind, the metallurgical troubles met with in these acid-resisting irons were slight compared with the ordinary practical troubles of the foundryman. Mention had been made of high shrinkage and brittleness, and the throwing out of this kish which tended to hinder pouring, and it was a great credit to men like Mr. Whitaker, who had grappled with these problems and had to a very great extent overcome them.

Experience Confirmed.

Mr. W. G. Thornton seconding the vote of thanks, said he had had some little experience with these irons and he could confirm Mr. Whitaker's statement that it was a most interesting job. Three or four years ago the firm with which he was associated had an inquiry for some tanks of acid-resisting material. They overcame all the troubles in regard to analysis, cupola practice, etc., but where they came up against the great difficulty was in the ordinary practice with these irons in the foundry. From the analysis point of view the dealing with these irons was simple if a firm had a chemist and the necessary tackle. The cupola part was simple to-day, but the difficulty was in the practice; in his experience they found they did not heat the iron quickly enough. One learned, of course, by mistakes, and he believed they were just getting nicely used to the job when they had to stop.

Mr. Whitaker mentioned an interesting point in speaking of melting. The bed must be kept well up the cupola. In his (Mr. Thornton's) experiments there was trouble with gates and runners, but when they could gate them in the middle of a job they were satisfactory, but if placed at one end it filled up the flange. The more runners they placed on it the better. Mr. Thornton said he, like Mr. Poole, was surprised to hear Mr. Whitaker say castings from these irons could be machined. His experience was that the material would scrape, but he did not call that machining. In drilling a hole one could do about four revolutions per minute, and he did not call that machining. Boring a hole was very slow, and they could be ground more quickly than machined. In regard to sands, his experience was that a very open sand was desirable. Personally, he would advise top running invariably; if they bottom-ran, the carbon in solution would deposit kish right at the top of the casting. It was policy to avoid cores as much as possible, but when essential he used ordinary green sand. A very important point, he proceeded, was that of percentage of phosphorus. In his experiments they had 0.12 or 0.15 per cent., and if varied in the least it altered the carbon content. They found the phosphorus very difficult to control. They had to use a great deal of steel scrap to get the phosphorus down to what they required. The pig-iron used contained about 12 per cent. silicon.

Machining Troubles.

Mr. Welford said he would be glad to know what amount of super-heat was involved in Mr. Whitaker's castings. Most of the high-silicon irons, he believed, were proprietary brands, and the bulk of the responsibility when used was on the moulder. The tensile strength, Mr. Welford believed, was about 6 tons per sq. in., and the flange ought to meet that. He would like to know whether the machining, as spoken of by Mr. Whitaker, gave a clean surface. Personally, he thought it must be rather rough.

Mr. Whitaker: Yes, very crumbly.

Mr. Welford said that in cupola practice he thought light charges were the rule.

Mr. Whitaker replied that 4 to 4½ cwt. was normal, but the first two charges were about 3 to 3½ cwt.

Mr. Welford said he believed the iron was a mixture of wrought iron, steel, high-silicon pig and ferro silicon, and he believed antimony was also used, to the extent of about 0.1 per cent., and had a good influence. In making pipes, when the metal was run towards the end, he would presume that there was an accumulation of kish in the flange at the end.

Mr. Poole, supporting the vote of thanks, said Mr. Whitaker was to be complimented on having the pluck to bring before the Branch something that was quite new. Mr. Whitaker's experience was valuable to himself and also to the metallurgist, because he was able to speak as the craftsman on the job. Mr. Whitaker's Paper should be an encouragement to many other members to come forward to give their fellow craftsmen some little enlightenment by comparison of experiences and practical insight. Many members, he thought, could really provide very interesting and generally helpful Papers on their own particular line of work in the trade. A great deal of good must come of an ever-closer contact between the craftsman on the job and the technical man.

The motion was carried unanimously, Mr. Whitaker briefly responding.

Gazette.

The following amended notice has been substituted for that published in the *London Gazette* of February 24, 1928:—Mr. C. G. Bushell, 163, Cole Valley Road, Hall Green, Birmingham, ironmaster, and carrying on business at Walsall as Birchills Iron and Steel Company. Court—Walsall. No. of Matter—2 of 1928. (By Transfer from Birmingham.) Trustee: Alldritt, Walter Ernest, Waterloo House, 20, Waterloo Street, Birmingham, Chartered Accountant. Date of Certificate of Appointment—February 20, 1928.

Institute of British Foundrymen.

LONDON JUNIOR SECTION.

A general meeting of above was held in the offices of The Foundry Trade Journal on February 24, Mr. P. Ellis (chairman) presiding.

A Paper entitled "Patternmaking" was read by Mr. F. Cummings (vice-chairman), who commenced with a few historical notes concerning the growth of the trade.

He said he thought he was justified in his opinion that men had made models in wax as far back as 2205 B.C. In any case, it was possible to see for oneself ancient bells, vessels for the use of food and drink (used in the ritual worship of ancestors), and many cast bronze figures which were fine pieces of workmanship.

The method adopted by the Chinese for casting these models was well worthy of note. In the first place the vessel or object to be cast was modelled in wax over a fireproof core and then covered with a fireproof coating. The wax was then melted away, being replaced by an alloy of copper and tin. Thus, after the removal of the core and outer coating and a touching-up of the raw edges, the original wax model was reproduced in the metal alloy.

In the best work, such as one finds in the earlier specimens, the fine relief ornaments showed hardly any traces of hand finishing. "Soapstone" moulds were used for casting the metal rings, bangles, etc., used in Egypt about 1500 B.C.

Patternmaking to-day was a vastly different proposition, and a journeyman has now to work to very fine limits, both as regards size and price. He is faced with great difficulty as far as material at his disposal is concerned, because however careful he might be in the choice of the piece or pieces of timber for a particular job, he cannot say definitely how much the wood will shrink, etc.

It would be absurd to say that a certain type of pattern must be made in a certain manner; nevertheless, there are some rules which ought naturally to be followed.

The older a journeyman gets the greater does he realise the limitations of his own knowledge. In making patterns for steel work, it was always well to remember that wherever possible cores should be made in halves. A full core box was often made when a half-box would have answered the purpose.

By means of sketches the author then explained the most suitable methods, in his opinion, of making certain jobs. That it paid to make a good pattern went without saying, but many patterns were spoilt by not having rapping plates, although the question of the correct position for a rapping plate was always a very mystifying one to him.

An interesting discussion followed, after which a vote of thanks was accorded to the lecturer.

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers report in their Statistical Bulletin for January that the number of blast furnaces in operation at the end of January was 148, a net decrease of 1 since the beginning of the month, 9 furnaces having ceased operation and 8 having been put into blast; this compares with 152 furnaces in blast at the end of January, 1927. The production of pig-iron last January amounted to 560,500 tons, compared with 559,100 tons in December and 434,600 tons in January, 1927. Production of steel ingots and castings last January amounted to 626,200 tons, compared with 604,900 tons in December and 730,700 tons in January last year.

Harriman Manganese Ore Concession.—The exports of manganese ore from Russia in January under the Harriman concession are returned at 15,630 tons, as against 8,518 in December. Of the January shipments 8,560 tons went to the United States, 5,561 tons to France, and 1,509 tons to Germany.

The Black Heart of Malleable Iron.

O. Quadrat and J. Koritta * have carried out a number of experiments with malleable iron in order to determine the mechanical properties of the black heart and to find out the best method of heat-treatment. The samples (plates of 7.87 × 3.15 × 0.79 in.) were cast from white iron melted in an acid open-hearth furnace. The composition of the iron is given in Table I. After being cooled, the samples were annealed for 60 hours in ore or sand. The annealing temperature was 980 to 1,000 deg. C. at the bottom of the furnace and 920 to 940 deg. C. at the top. The heating period of the furnace was 60 hours, the cooling period 60 to 72 hours. The white outside of the annealed samples consisted of a ferritic layer, the thickness of which was 0.00394 to 0.0118 in., followed by a pearlitic layer of 0.0263 to 0.0669 in. There was a distinct boundary to be seen between the pearlitic layer and the black heart. The carbon content of the black heart is given in Table II; the percentages of the other elements were not changed by the annealing process with the exception of the sulphur. When the samples were annealed in ore the sulphur content was increased by 1.5 to 10.0 per cent.; the sulphur content of the ore was thereby diminished by 36.7 to 55.8 per cent. When the annealing process was done in sand, the sulphur contents of the samples were slightly diminished. The Baumann test showed that the sulphur was regularly distributed across the whole area of the annealed samples, from which fact it may be concluded that the diffusion of the FeS takes place very rapidly.

Test samples were taken from the black heart in order to examine the tensile strength, elongation, reduction of area, impact strength, hardness, specific gravity. The experimental data are given in Table III and Fig. 1. For comparison, Table IV gives the values of the tensile strength of samples, the white outside of which had not been removed. The samples for the tensile test had a gauge length of 4.33 in. and a diameter of 0.433 in. The dimensions of the impact test samples were 2.36 × 0.394 × 0.394 in.; the notch was 0.0787 in. deep with an angle of 45 deg. The tests were made with a machine of the pendulum type. The Brinell test was made with a load of 1,000 kg. for one minute. The specific gravity of the original white iron was examined with the aid of a picnometer; the value was found to be 7.75 grs. per cu. c. The specific gravity of the black heart was examined by measuring and weighing test samples of 6.3 × 0.394 × 0.394 in.

If the assumption be correct that there is no cohesion between the nodules of the temper carbon and the grains of the ferritic matrix, the tensile strength of the latter can be calculated from that of the black heart. The volume of the temper carbon in 100 units of the black heart is:—

$$V_c = \frac{\text{S.G. of the black heart} \times \text{percentage of temper carbon}}{\text{S.G. of temper carbon}},$$

and the volume of the ferrite is 100 — V. In the cross section unit there is the same amount of constituents as in the unit volume. Therefore, when P is the tensile strength of the black heart, that of the ferritic matric is $P' = \frac{100 \times P}{100 - V_c}$ t/sq. in. The calculateu values are given in Table III, column 9.

Further experiments were maue in order to determine the mechanical properties of the black heart at different temperatures. The results of

TABLE I.—*Composition of Specimens.*

Sample No	T.C.	Gr.	Mn.	Si.	P.	S.	Cu.	As.	Annealed in
1	2.95	0.01	0.14	0.72	0.096	0.0784	0.169	0.072	Ore.
2	2.92	0.01	0.14	0.72	0.094	0.0776	0.173	0.072	,,
3	2.95	0.01	0.14	0.72	0.096	0.0784	0.170	0.075	,,
4	2.96	0.01	0.14	0.73	0.095	0.0784	0.170	0.070	,,
5	2.945	0.007	0.14	0.72	0.094	0.0774	0.168	0.070	,,
6	2.94	—	0.08	0.78	0.082	0.0553	0.185	0.077	Sand.
7	2.95	—	0.08	0.78	0.082	0.0553	0.180	0.079	,,
8	2.955	—	0.08	0.784	0.082	0.0553	0.183	0.079	Ore.
9	2.58	—	0.08	0.89	0.095	0.0505	0.185	0.060	,,
10	2.91	—	0.13	0.75	0.085	0.0600	0.190	0.065	Sand.
11	2.91	—	0.13	0.74	0.085	0.0600	0.190	0.065	Ore.
12	2.595	—	0.11	0.82	0.064	0.0490	0.192	0.073	Sand.
13	2.60	—	0.11	0.82	0.064	0.0490	0.190	0.070	Ore.
14	2.65	0.005	0.13	0.83	0.097	0.0553	0.186	0.076	Sand.
15	2.65	0.005	0.13	0.83	0.097	0.0553	0.192	0.072	Ore.
16	2.52	—	0.15	0.80	0.094	0.0648	0.192	0.072	,,
17	2.52	—	0.15	0.80	0.094	0.0648	0.190	0.074	,,
18	2.83	—	0.16	0.80	0.092	0.0548	0.183	0.075	,,
19	2.84	—	0.16	0.80	0.092	0.0550	0.160	0.060	,,
20	2.80	—	0.18	0.79	0.093	0.0564	0.156	0.065	,,
21	2.80	—	0.18	0.79	0.093	0.0564	0.154	0.065	,,
22	2.51	0.01	0.11	0.81	0.086	0.0640	0.161	0.060	,,

TABLE II.

Sample No.	T.C.	Temper carbon.	C.C.	Carbon gasified.	Carbon gasified in percentages of total carbon.
1	2.865	2.82	0.045	0.085	2.88
2	2.815	2.77	0.045	0.104	3.60
3	2.835	2.802	0.033	0.115	3.90
4	2.80	2.75	0.050	0.160	5.40
5	2.85	2.82	0.030	0.095	3.22
6	2.895	2.74	0.155	0.045	1.53
7	2.816	2.70	0.116	0.134	4.55
8	2.88	2.835	0.045	0.075	2.54
9	2.46	2.415	0.045	0.118	4.67
10	2.815	2.762	0.053	0.095	3.27
11	2.858	2.808	0.050	0.052	1.78
12	2.48	2.42	0.060	0.115	4.43
13	2.525	2.46	0.065	0.075	2.88
14	2.585	2.493	0.092	0.065	3.45
15	2.555	2.493	0.062	0.095	3.59
16	2.36	2.31	0.050	0.160	6.35
17	2.318	2.262	0.056	0.202	8.03
18	2.76	2.717	0.043	0.070	2.64
19	2.692	2.636	0.056	0.148	5.21
20	2.732	2.652	0.080	0.068	2.43
21	2.64	2.555	0.055	0.156	5.57
22	2.405	2.32	0.085	0.105	4.18

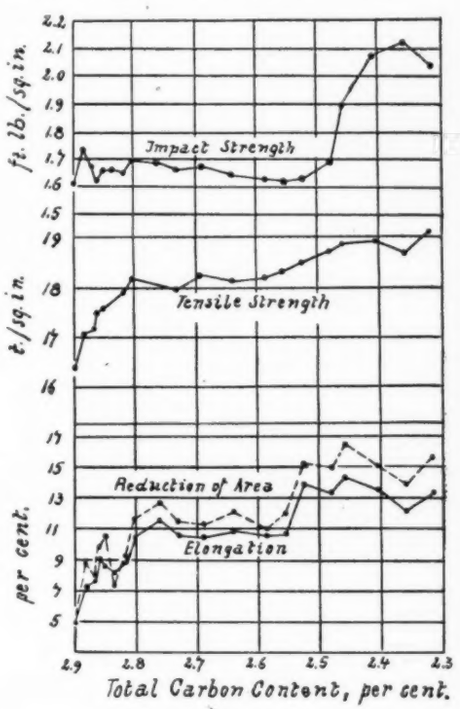

Fig. 1.

TABLE III.

Sample No.	Total carbon. Per cent.	Tensile strength. t/sq. in.	Elongation. Per cent.	Reduction of area. Per cent.	Impact strength. ft. lb./sq.in.	Ball Hardness. t/sq. in.	Specific gravity.	Tensile strength of the ferritic matrix. t/sq. in.
6	2.985	16.38	4.85	4.95	1.600	54.6	7.202	18.03
8	2.88	17.10	7.28	8.80	1.735	53.9	7.209	18.80
1	2.865	17.20	7.60	7.81	1.668	49.8	7.256	18.93
11	2.858	17.55	9.10	9.80	1.612	48.2	7.214	19.30
5	2.85	17.60	8.65	10.60	1.657	47.6	7.295	19.43
3	2.835	17.75	8.17	7.15	1.657	48.4	7.230	19.50
7	2.816	17.88	7.37	7.15	1.792	46.5	7.235	19.66
10	2.815	17.92	8.69	9.33	1.523	46.6	7.236	19.70
2	2.815	18.10	10.68	11.03	1.612	45.6	7.247	19.88
4	2.80	18.22	10.45	11.65	1.690	43.5	7.227	20.08
18	2.76	18.10	11.54	12.65	1.680	52.2	7.201	19.88
20	2.732	17.98	10.60	11.45	1.657	49.4	7.245	19.35
19	2.692	18.30	10.45	11.35	1.668	53.5	7.252	20.08
21	2.64	18.17	10.90	12.10	1.635	50.5	7.277	19.88
14	2.585	18.25	10.60	10.88	1.623	48.5	7.287	19.88
15	2.555	18.40	10.75	12.02	1.612	46.4	7.253	20.20
13	2.525	18.55	13.80	15.30	1.623	50.5	7.291	20.20
12	2.48	18.80	13.26	15.08	1.680	49.2	7.320	20.45
9	2.46	18.92	14.30	16.60	1.892	42.9	7.313	20.55
22	2.405	19.00	13.45	15.10	2.070	46.1	7.335	20.55
16	2.36	18.78	12.10	13.90	2.115	51.5	7.324	20.40
17	2.318	19.18	13.12	15.60	2.035	53.9	7.343	20.75

TABLE IV.

Chemical comp. like Sample No.	Tensile strength, t/sq. in.	Elongation Per cent.
1 to 5	27.3	4.0
6 ,, 8	30.3	4.9
9	22.5	7.0

* Die Giesserei, 1927, No. 46, pp. 849,54. No. 50, pp. 865/70.

the impact and tensile tests are given in the Tables V and VI in percentages of the test figures at room temperature. The figures of Table V are

Table V.

Temperature. Deg. C.	Impact test value. Per cent
− 20	82.4
− 12	82.1
− 10	88.6
+100	93.5
+200	92.5
+300	92.7

Table VI.

Temp. Deg. C.	Tensile strength.	Elongation.	Reduction of area.
100	97.0	151.0	92.2
	83.2	74.3	83.6
200	92.5	73.3	97.5
	91.5	73.3	92.0
3,000	94.2	81.0	73.5
	92.4	81.0	73.5

the average values of four to eight experiments. It is to be seen that the influence of low temperatures on the mechanical properties is more accentuated than that of temperatures of 100 to 300 deg. C.

In order to determine the influence of the cooling rate on the mechanical properties, test bars were heated to temperatures of 600 to 900 deg. C., kept at temperature for 30 minutes (for one hour at 950 deg. C.) and then (*a*) quenched in water (15 deg. C.) kept in motion; (*b*) slowly cooled in air; and (*c*) slowly cooled in the furnace.

The results of the impact and hardness tests (average values of four to six experiments) are given in Table VII in percentages of the test

Table VII.

Cooled from	600	700	750	800	900	950 deg. C.
			Impact test figures, per cent.			
In water	91.33	96.66	93.51	55.83	15.00	10.12
In air	101.37	100.63	97.68	85.26	23.78	12.90
In furnace ..	100.80	97.84	96.40	84.85	27.34	22.43
			Hardness figures, per cent.			
In water	117.81	106.70	117.66	168.35	503.00	—
In the air ..	114.49	111.30	119.30	139.70	310.20	243.50
In furnace ..	101.41	106.37	110.67	131.73	249.00	214.70

values at room temperature. The microscopic examination revealed the following facts. At 600 and 700 deg. C. no solution of the temper carbon could be observed. At 700 deg. C. a slight solution of the temper carbon took place. At 800 deg. C. the original ferrite grains could not be identified in the quenched samples; the slowly cooled samples showed some pearlite. At 900 deg. C. the solution of the temper carbon in the matrix was complete; the texture of the quenched samples showed the intermediate stages between troostite and osmondite; that of the slowly cooled samples was pearlitic. The same was the case with the samples cooled from 950 deg. C.; here the quenched samples showed a martensite-like structure. From the figures given in Table VII it can be concluded that by heating the mechanical properties of the black heart are not changed when the temperature does not exceed 750 deg. C. To check these results tensile tests were carried on with samples kept at high temperatures in the same manner as stated above and being slowly cooled in the air; moreover the combined carbon contents were examined in these samples. The experimental results recorded in

Table VIII.

Cooled from Deg. C.	Tensile strength.	Elongation.	Reduction of area.
600	101.9	94.0	106.9
700	103.0	102.6	87.6
750	103.0	91.0	82.2
800	104.9	65.4	51.5
900	206.7	—	—
950	187.0	—	—

the Tables VIII and IX show that a perceptible solution of the temper carbon does not take place except at temperatures exceeding 750 deg. C.

In further experiments the cooling period from temperatures between 900 and 600 deg. C. was changed from ½ to 4 hours in order to find out whether the poor mechanical properties of the heated samples could be improved by very slow

Table IX.

Cooled from	600	700	750	800	900	950 deg.C.
	Combined carbon, per cent.					
In water ..	0.06	0.10	0.15	0.24	0.86	1.16
In air ..	0.05	0.08	0.11	0.30	0.98	1.21
In furnace ..	0.06	0.09	0.07	0.33	1.02	1.04

cooling. It was found that the impact strength was not changed until the cooling period was 4 hours; then the impact value was 38.6 per cent. of that of the untreated material. On the other hand, by increasing the cooling period the Ball hardness number gradually decreased from 237.4 to 145.0 per cent. of the value of the untreated material.

Ingot-Pouring and Stripping at the Fordson Works.

The layout, equipment and methods of handling raw materials and of pouring the steel at the Fordson plant of the Ford Motor Company, Fordson, Mich., U.S.A., differ from those followed by the average open-hearth department on that side of the Atlantic.

The charging floor is 72 ft. wide, and is paved with brick. A 600-ton, cylindrical-type hot-metal mixer, is located at one end in line with the open-hearth furnaces. Ladles of hot metal from the blast furnaces are brought into the pouring bay and their contents emptied into the mixer, from which it is conveyed to the open-hearth furnaces in a 65-ton ladle. When the desired amount of metal is poured, the ladle is transferred by crane to a truck which operates on a standard-gauge track laid lengthwise of the building opposite the furnaces.

Seven 100-ton basic open-hearth furnaces are housed in the steel-making department, four being of the tilting type and three of the stationary type. The tilting furnaces are built with hearths 15 by 37 ft., and can be tilted 22½ deg. forward, or 10 deg. backward by a horizontal-screw mechanism. The fronts, ports and ends are water-cooled. The walls are reinforced by buckstays made of steel castings. Each furnace is 42 ft. 7½ in. long from face to face of chills. Six of the furnaces are built with five charging doors, each of which is water-cooled and raised or lowered by a chain which operates over a motor-driven drum. The seventh furnace is equipped with two wide charging doors to facilitate charging large pieces that cannot be cut with the shears.

Each furnace is fired with tar from the Company's coke ovens; but burners are provided so that gas and oil can be used as fuel if desired. Tar is brought to the works in tank wagons and discharged into storage tanks built outside the open-hearth building. Waste-heat boilers operate in conjunction with each furnace. These are of the vertical, single-pass, fire-tube type, and are rated at 400 h.p. The boilers are installed in a 30 ft. bay between the stock yard and the charging floor.

The steel is tapped into a 120-ton ladle and is transferred from the furnace to the pouring platform by a 175-ton crane. Two cranes of this capacity serve the pouring floor. At most open-hearth steelworks the practice is to pour the steel into moulds consecutively, each ingot weighing from 2 to 4 tons. The practice of the Ford plant, however, is to pour four ingots simultaneously, each weighing about 1,680 lbs. The moulds, oval-shape and fluted on the interior, measure 12 in. on the long diameter of the oval, 10 in. on the short diameter and are 60 in. long. Approximately 120 moulds are required to handle a heat.

The bottom opening of the moulds used by the Ford Company employ a two-plug closure. The upper plug is only a splash disc made of heavy-gauge sheet steel, and its function is to receive the impact of the hot metal during the pouring operation, and prevent the steel cutting the bottom walls of the mould. This disc is seated in a recess so that all lateral movement is prevented. The bottom plug, of cast iron, is slightly conical, and fits into a hole in the mould bottom.

Each ingot stool holds eight moulds arranged four in a row. The train of moulds passes beneath a pouring dish which is 2 ft. deep and is equipped with four nozzles. The reservoir is lined with 6 in. of fire brick and is equipped with a cast-steel cover having a 4-in. refractory lining. The cover is equipped with a rectangular slot 5 ft. long and 1 in. wide through which metal from the ladle is poured. During the pouring operation, the large ladle remains in a fixed position. The pouring dish may be racked transversely through a distance of 39 in. When four ingots are poured, the reservoir is spotted over the four ingots on the opposite side, the rectangular slot in the reservoir cover permitting the continuous flow of metal from the ladle.

When a batch of eight moulds are poured, the ingot train is moved forward a car length and the operation is repeated. From 20 to 25 min. are required to dispose of the heat. By this method of teeming there is no segregation of manganese and the variation in the chemical constituents of the ingot is insignificant. Whatever slag remains in the steel ladle after the heat is poured, is dumped in a slag bucket placed near one end of the pouring floor.

After the steel is poured, the mould train is shifted into the stripper building, adjacent to the open-hearth department. Here the hot tops, made from waste sand from the foundries, are removed, and the ingot car is spotted over a stripping device composed of eight rams. These rams are elevated simultaneously and pressed against the cast-iron bottom plugs, loosening the ingots from their moulds. The mould train then is transferred to the soaking-pit building nearby, where the pit crane charges the ingots into the furnaces. "Iron Trade Review."

Personal.

Mr. B. D. F. Docker has been elected director and deputy chairman of the Metropolitan-Vickers Electrical Company, Limited.

Wills.

Leigh, W. G., of Shrewsbury Road, Bolton, iron merchant £5,790

Workman, F., Strandtown, Belfast, one of the founders and for many years a director of Workman, Clark & Company, Limited £778,103

Fergusson, W. R., late chairman of Barclay Curle & Company, and formerly a director of the North British Diesel Engine Works £130,295

Applications for Trade Marks.

"Translay."—All goods included in Class 8. Metropolitan-Vickers Electrical Company, Limited, 4, Central Buildings, Westminster, S.W.1.

"Midcyl."—Metal castings in the rough, but not including pig-iron. The Midland Motor Cylinder Company, Limited, Dartmouth Road Foundries, Dartmouth Road, Smethwick, near Birmingham.

"Midcyl" in a special type.—Metal castings in the rough, but not including pig-iron. The Midland Motor Cylinder Company, Limited, Dartmouth Road Foundries, Dartmouth Road, Smethwick, near Birmingham.

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Trade Talk.

Only three shipbuilding orders have been booked by Wear shipbuilders since the turn of the year. The latest order is one placed with S. P. Austin & Son, Limited, by France, Fenwick & Company for a collier of 4,000 tons.

A further application having been made under the Safeguarding of Industries procedure by the Wrought Hollow-ware Trade Employers' Association for the imposition of a duty on enamelled hollow-ware, the Board of Trade have reappointed the Committee to consider the present position in the industry.

The Comptoir Sidérurgique de France has secured from the Turkish Government an order for about 40,000 tons of permanent-way material for the railways in Anatolia to be constructed by the Swedish-Danish group, headed by Nydgvist & Holm. The whole of this material is to be supplied by the De Wendel and Micheville concerns.

Walker, Crosweller & Company, of 54-58, Queen Elizabeth Street, London, S.E.1, announce that they have taken over the sole selling rights for the British Isles and certain countries abroad of the Dielectrimeter. This is the portable instrument used for testing the dielectric strength of oils which was hitherto sold by the Empson Electrical Engineering Company, Limited.

Further industrial developments are probable in Dudley in the near future, Wright's Forge & Engineering Company, of Tipton, Staffs., having approached the Council with respect to the purchase of two and a-half acres of ground on the Priory Estate, near to Castle Mills Works, now inoperative. Another firm is also contemplating the purchase of a site in the borough.

David King & Sons, Limited, ironfounders, Glasgow, who have acquired the business of Marsden & Naylor, of Foundry Field, Skipton, have commenced the production of castings at Skipton, and the ceremony of tapping the first iron from the cupola was performed by Mrs. John King, the wife of the chairman of the directors. The foundry will provide employment for 30 to 40 men, and the firm contemplate extensions that will provide work for a much larger number.

Sir Philip Dawson, M.P., at the 75th anniversary dinner of the London Association of Foremen Engineers, on March 2, said that the great difficulties which confronted the engineering industry in this country to-day were especially pressing in the case of the electrical branch. British electrical manufacturers to make a very slight margin of profit had to quote prices which were 27 per cent. higher than those of their Swiss, Belgian and Italian competitors. It was very regrettable that the corporations of many of our great cities were placing orders for electrical machinery in foreign countries.

While the output from the Clyde shipbuilding yards during February is not a record one, the production over the first two months of 1928 is the highest for the period in the history of the industry. In all, 16 vessels measuring 61,751 tons, represent February's total, while in the previous month there were 12 vessels, measuring 56,013 tons put into the water—an output for the year of 28 vessels and 117,764 tons. In February of last year there were 13 vessels of 7,978 tons, and the total for 1927 at that time was 14 vessels of 13,187 tons. For the first two months of 1926 the aggregate was 51,069 tons, and for 1925, 67,752 tons.

Mr. W. Strachan, a former director and secretary of Workman, Clark & Company, Limited, and a group acting with him, have purchased the shipyard and engineering works of the firm at Belfast from the joint receivers, who were acting on behalf of the prior lien debenture-holders. Mr. Strachan has been connected with the firm of Workman, Clark & Company since July, 1901. He is a native of Glasgow, and prior to accepting the appointment in Belfast he was with the firm of William Robertson, a well-known Clydeside firm of shipowners. On the change of ownership of Workman, Clark & Company in 1920 Mr. Strachan continued as secretary, and finally he became a director.

The English Electric Company, Limited, have secured through their agents, the Associated British Manufacturers (Egypt), Limited, an important contract from the Ministry of Public Works, Egypt. This contract, which amounts to about £185,000, is for the complete plant for the Belqas Power Station, and includes three "English Electric" 2,500-kw. turbo alternator sets, the necessary transformers, switchgear, etc., boiler plant and coal-handling plant. It is understood the Belqas Station, which is to be situated 14 miles north of Mansura on the Belqas Canal will supply power for the operation of the new pumping stations in connection with the Egyptian Government's irrigation schemes and for conversion of some of the existing stations from engine drive to electrical drive.

The Duffield Iron Corporation, Limited, have been formed with a capital of £250,000, divided into £100,000 7½ per cent. cumulative preference shares of £1 each, and 3,000,000 ordinary shares of 1s. each, all of which will be issued credited as fully paid up to the vendors. The directors of the company are: Sir George Leon, Bart., director, Henry Gardner & Company, Limited (chairman); Mr. Arthur Colegate, director, Madeley Collieries, Limited; Mr. Arthur Windsor Richards, consulting engineer and metallurgist; Mr. Norman Liversidge (chairman), James Watkinson & Sons, Limited; Hon. Clarence Napier Bruce, director, Lindley Duffield & Company, Limited; Mr. Peter Lindsay, director, Morgan Crucible Company, Limited; and Mr. Frederick Lindley Duffield, chairman and managing director, Lindley Duffield & Company, Limited (managing director). The secretary is Mr. Norman McLean Poole, and the offices are at Imperial House, Kingsway, W.C.2. The company was incorporated on February 9, 1928, particularly to prove and develop commercially the Duffield processes for reduction of ores, and to acquire patent rights. Mr. Duffield claims to have discovered that in reducing iron ore to the metal iron by carbon, sufficient gases are generated in this re-action to supply the whole of the heat necessary for the making of iron, thereby using only one-third of carbon in the form of waste slack coal against that used in the blast-furnace in the form of coke. The metal product has reasonable prospects of superiority to pig-iron. Mr. Duffield further claims to have discovered a means of making from waste slack coal a superior type of gas which, by reason of its composition and temperature, supplies the ideal reducing agent of iron ore to high purity iron, or mild steel, as required, at the same time furnishing the total fuel needs of electric melting by using no further quantity of carbon contained in the waste slack coal than is consumed in the blast furnace from the more costly coke. In the Duffield process, however, the product is refined iron or steel. The vendor company claims that the prime factors of Mr. Duffield's processes if proved commercially should reduce the cost of the manufacture of iron and steel by one-half, and should once more make England the cheapest and best market in the world.

Contracts Open.

Birmingham, March 19.—5,000 yds. of 24-in internal diameter socket and spigot steel pipes, lined centrifugally with concrete, for the Water Committee. The Secretary of the Water Department, Council House, Edmund Street, Birmingham. (Fee £1 1s., returnable.)

Birmingham, March 19.—10,000 yds. of 62-in. internal diameter socket and spigot steel pipes, lined centrifugally with concrete, together with the necessary specials, etc., for the Water Committee. The Secretary of the Water Department, Council House, Edmund Street, Birmingham. (Fee £1 1s., returnable.)

Blackpool, March 19.—Extra-high-tension feeders, low-tension feeders, distributors, disconnecting pillars, boxes and services, for the Corporation. Mr. C. Furness, the borough electrical engineer, Electricity Works, West Caroline Street, Blackpool. (Fee £1 1s., returnable.)

Exeter, March 17.—(5) Cast-iron pipes; (11) miscellaneous iron castings, etc., for 12 months from April 1, for the City Council. Mr. T. Moulding, city engineer and surveyor, Municipal Offices, Exeter.

London, S.E.1, March 16-30.—(2) 761 tons of flat-footed 60-lb. B.S. steel rails; (3) 30 tons fishplates; and (4) 105 tons bearing plates for above rails; (5) 33,800 yds. lead-covered electric cable, etc.; (6) 12-in. motor-driven rolling mill for cupro nickel and brass, for the India Store Department, Belvedere Road, Lambeth, S.E.1. (Fee 5s. for each schedule, non-returnable.) Tenders due March 16 for (2) to (5), and March 30 for (6).

Manchester, March 19-26.—Supply and erection of (a) (203) 18 in.-30 in. cast-iron low-pressure water pipework and supports, also the dismantling of similar pipework; (b) (B. 63) low-pressure water and oil pipework, etc., for auxiliary services (section "B"), for the Electricity Committee. Mr. H. C. Lamb, chief engineer and manager, Electricity Department, Town Hall, Manchester. (Fee £1 1s. for each, returnable.) Tenders due for (a) March 19, (b) March 26.

Sleaford, March 19.—Providing and laying 5,764 yds. of 2-in. cast-iron water main and fittings, for the Sleaford Rural District Council. Mr. E. H. Sills, the engineer, Council Offices, Northgate, Sleaford.

Southport, March 21.—374 tons of cast-iron spigot and socket pipes and specials, 15 in. in diameter, for the Southport, Birkdale and West Lancashire Water Board. Mr. C. B. Ede, engineer and manager, 14, Portland Street, Southport.

Patent Specifications.

The following list of Patent Specifications Accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

26,838. Pneumatic Conveyance & Extraction, Limited, and Smith, W. A. Pneumatic suction apparatus for the conveyance of granular materials. October 27, 1926. (Addition to 281,811.) 284,030.

27,264. Lea, J. E. Apparatus for the measurement of granular materials. November 1, 1926. 284,033.

3,235. Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges.). Manufacture of finely divided metals from metallic carbonyls. February 4, 1927. (Addition to 269,677.) 284,087.

5,745. Dicker, S. G. S. (Wiarda & Company, J. C.). Treatment of manganese ores. March 1, 1927. 284,098.

15,563. Fouquet, E. Metal-shearing machines. (June 17, 1926.) 272,901.

15,622. Steam Production Corporation. Furnaces. (July 31, 1926.) 275,177.

18,575. Hornsey, J. W., and Coley, H. E. Production of iron from iron ores. July 26, 1926. 284,040.

29,532. Last, J. Sand moulds for making castings. November 22, 1926. 284,425.

31,666. Brayshaw Furnaces & Tools, Limited, and Newman, F. C. Milling-cutters. December 14, 1926. 284,437.

1,716. Croese, D. Treatment of ores for the production of metal. January 20, 1927. 284,459.

2,233. Pinches, A. E. and Willis, S. Eccentric rolls for rolling-mills. January 26, 1927. 284,463.

5,653. Scott, J. H., Scott, W., and Scott, F., trading as Scott Bros. & Son. Means for consuming smoke in boiler furnaces. March 1, 1927. 284,485.

8,068 Imray, O. Y. (National Automatic Tool Company). Metal-cutting tools. March 23, 1927. 284,495.

13,814. Freeze, J. R. Manufacture of spiral metal pipes. May 23, 1927. 284,518.

17,831. Buess, W. Rotary melting-furnaces. (July 16, 1926.) 274,451.

28,165. Anderson, P. Apparatus for sintering ore. November 9, 1926. 284,793.

28,230. Marshall, V. H. Apparatus for drawing metal tubes. November 10, 1926. 284,794.

29,345. Wittek, Dr. H. Process of reducing ores. (July 26, 1926). 274,803.

11,169. Siemens-Schuckertwerke Ges. Coal-dust furnaces. (December 17, 1926). (Addition to 270,295). 282,333.

11,649. Eaton, W. S. Process of electro-depositing chromium. May 2, 1927. 284,900.

12,518. Betz, P., and Wulf, H. Manufacture of metal-encased tubes. May 10, 1927. 284,903.

24,661. Schorn, H. Aluminium alloys. (September 18, 1926). 277,701.

27,839. Hermsdorf, E. Feeding-mechanism for coal-dust furnaces. (November 5, 1926). 280,181.

22,191. Cork, E., and Chalk, J. T. Chains for driving purposes. September 8, 1926. 285,101.

28,115. Eley, C. V. A. Furnaces. November 9, 1926. 285,126

28,138 and 28,139. Turner, B., and Ferro-Arc Welding Company, Limited. Manufacture of electrodes, etc., for use in depositing metal. November 9, 1926. 285,128 and 285,129.

28,393. Wiggin & Company, Limited, H., and Lobley, A. G. Electric furnaces. November 11, 1926. 285,147.

29,552. Bennis, A. W. Apparatus for removing ashes, etc., from furnaces. November 23, 1926. 285,181.

30,541. Siemens-Schuckertwerke Ges. Bright-annealing furnaces. (December 3, 1925.) 262,444.

16,020. Weyhenmeyer, Dr. E. Distributor for coal-dust furnaces. June 16, 1927. 285,300.

18,600. Kellner & Flothman Ges. Reversing-apparatus for gas, etc., valves of gas-fired furnaces and furnaces for metallurgical and other purposes. (July 31, 1926.) 275,206.

19,473. Marston, H. A. Burners used in burning pulverised fuel. July 22, 1927. 285,314.

Pig-iron in Norway.—A/S Bremanger Kraftselskap has obtained a concession for transmission of electric power to its projected new pig-iron producing plant in Bremanger, where preliminary construction work has already been started. It is expected that production will commence next summer. The plant is based on an annual output of 15,000 tons.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Nearing the end of the first quarter has been usually a quiet time in the Cleveland iron market, and this year has been no exception to the accepted rule, consumers generally having unfilled contracts on hand sufficient to meet current requirements. Tees-side producers of foundry pig, however, have no anxiety about the disposal of their output, and as a matter of fact an additional furnace was recently started in order to meet the increased demand. But there had been hopes that still more furnaces would be in blast by now, and it is the slow rate of expansion which is the chief source of disappointment. However, improvement may not be long delayed. Business with Scotland is better, foreign iron has been shut out of the home markets, and as the spring advances increased industrial needs should bring more buyers along. On the export side also the volume of foreign inquiry is considerable, and shippers are hopeful that a proportion of these inquiries will mature, especially as Continental iron is by no means so freely obtainable as was the case a couple of months ago. Cleveland prices show an increase of 1s., and are now:—No. 1 foundry iron, 68s. 6d. per ton; No. 3 Cleveland G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge, 64s. 6d. per ton.

The position in the market for hematite discloses little change for the better, a further reduction in output having been effected in the Tees-side area by laying idle another furnace, reducing the number in action on this grade of iron to ten. This drastic measure will, it is hoped, lead both to better prices and the liquidation of the stocks already in hand. The quotation for East Coast mixed numbers is a little firmer at 70s., but sales are still reported at 69s., so that weak holders have not yet been entirely eliminated. On the North-West Coast, Bessemer mixed numbers remain firm at 70s. per ton at works.

LANCASHIRE.—Current demand for foundry pig in this area continues on the slow side, although a more optimistic view is expressed in some quarters that a revival of more active buying may be confidently anticipated in the near future. For the present prices are fully maintained at their previous levels, Derbyshire No. 3 foundry holding at round 72s. 3d. per ton and Staffordshire makes at about 71s. 6d. per ton, both delivered Manchester or equal. Scottish brands are on offer at from 86s. to 87s. 6d. per ton, with Cleveland No. 3 at about 84s., also delivered locally.

THE MIDLANDS.—Some slight improvement in conditions may be noted in the South Staffordshire district, but in the main local ironfounders continue very badly situated for orders, and they are not at all anxious buyers for the time being. Quotations are unaltered as follow:—Northants. No. 3 is offered between 59s. and 60s.; most brands of Derbyshire No. 3 at 64s. and North Staffordshire No. 3 about 64s., while Lincolnshire and Cleveland No. 3 are 72s. 6d. and 80s. 9d. per ton respectively, and No. 3 Scotch is on offer from 88s. 6d. to 90s. per ton delivered stations in the Black Country area.

SCOTLAND.—Makers of Scotch foundry pig report a rather better demand, and no doubt consumers recognise that prices have reached bottom, and as a result of the strong position on the Continent and the continuance of the strike amongst the Swedish ore workers pig-iron quotations are now likely to advance. At the same time, founders are not able to report any improvement in their order books, and the pipe founders especially are very quiet. The light castings section is also slack, and their pig-iron requirements are limited. They have now ceased to buy Continental pig-iron, as the price is quite out of line.

Finished Iron.

Business in this class of material continues on a disappointing scale, and in Lancashire outputs at the bar mills only amount to about 50 per cent. of capacity. Makers, however, are holding very firmly to prices, quoting £10 per ton for crown quality and £9 10s. for second-grade material, including in each case delivery to buyers' works. In South Staffordshire the quoted prices for crown iron are from £9 5s. to £10 5s., and nut and bolt iron £8 17s. 6d. to £9 per ton delivered locally. Staffordshire marked bars are quoted at £12 10s. per ton at makers' works, and the mills making this class of bar continue to be fairly well engaged.

Steel.

Slightly better conditions may be noted in some sections of the home steel industry, due in some measure to the improvement in shipbuilding demand, and partly to a recent movement to reduce prices of British semis. In this connection it is reported that last week the heavy steelmakers in the North of England decided upon a reduction of 10s. per ton in the official quotation for hard and medium steel billets, bringing the price down to £7 12s. 6d. and £7 2s. 6d. per ton respectively, whilst for soft billets there is no fixed price, though £6 15s. may be suggested as an average figure.

Scrap.

Reports from the principal centres of the scrap metal trade vary to a considerable extent, both in volume of business passing and the prices quoted for foundry material. In the Midlands, however, the Birmingham foundries are still taking good supplies of cast-iron scrap. For machinery quality in cupola sizes 70s. per ton, delivered, is offered. There is not, however, such a good demand for the lighter qualities, and they are weak at 53s. per ton, delivered. In Scotland machinery cast-iron scrap is quoted at 70s. per ton and heavy ordinary quality 5s. per ton less, the latter being a little more difficult to obtain. Old cast-iron railway chairs, which are rather scarce, are quoted at 67s. 6d. to 70s. per ton; light cast-iron scrap is quoted around 57s. 6d. to 60s. per ton. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Affected to some extent by depressing American advices, the market for warrant copper has lost some of its recent buoyancy, although, so far, values have been fairly well maintained slightly above the previous week's level. There has been a further considerable contraction of the premium on cash and near copper, now amounting to 3s. 9d. per ton, compared with 12s. 6d. not many weeks ago. The immediate outlook is not promising, but consumers are encouraged in their reserve by a very fair supply of electrolytic offering outside of the combine at well under the figures still retained by the latter.

Official closing prices of standard copper have been as follow :—

Cash : Thursday, £61 2s. 6d. to £61 3s. 9d.; Friday, £61 6s. 3d. to £61 7s. 6d.; Monday, £61 8s. 9d. to £61 10s.; Tuesday, £61 3s. 9d. to £61 5s.; Wednesday, £61 3s. 9d. to £61 5s.

Three Months : Thursday, £61 1s. 3d. to £61 2s. 6d.; Friday, £61 3s. 9d. to £61 5s.; Monday, £61 6s. 3d. to £61 7s. 6d.; Tuesday, £61 2s. 6d. to £61 3s. 9d.; Wednesday, £61 5s. to £61 6s. 3d.

Tin.—The issue of the month's official statistics has had very little actual effect upon the market for standard tin, some good buying developing later, with a slight recovery in values both cash and forward. According to Messrs. Ricard & Freiwald's statement, stocks of tin landing and afloat in Europe and America at the end of February amounted to 17,254 tons, as against 15,017 tons in January, showing an increase of 2,237 tons in the total visible supply. Monthly supplies from all sources amounted to 11,812 tons, as against 9,096 tons for the previous month, deliveries in that period being 9,575 tons, as against 9,689 tons for January.

Official closing prices of standard tin have been as under :—

Cash : Thursday, £230 2s. 6d. to £230 5s.; Friday, £229 10s. to £229 15s.; Monday, £228 17s. 6d. to £229; Tuesday, £224 10s. to £224 15s.; Wednesday, £225 to £225 2s. 6d.

Three Months : Thursday, £232 10s. to £232 15s.; Friday, £231 15s. to £232; Monday, £231 5s. to £231 10s.; Tuesday, £226 15s. to £227; Wednesday, £227 5s. to £227 10s.

Spelter.—Commenting on the position in the market for ordinary spelter, Messrs. Rudolf Wolff & Company write:—The market remained steady throughout the week, but later there was a decline, and further easiness followed. The half-monthly figures published in America show that the stocks had increased by 300 tons, but the number of retorts operating had been reduced by 3,504 tons.

The following are the week's prices :—

Ordinary : Thursday, £25 5s.; Friday, £25 10s.; Monday, £25 7s. 6d.; Tuesday, £25 3s. 9d.; Wednesday, £25 5s.

Lead.—In the market for soft foreign pig the slightly lower level of values has proved attractive to consumers and others, and an improvement followed, which brought about a recovery from the lowest points touched. Arrivals during March are expected to be rather light, and this should have some effect on values should the normal spring buying materialise, and especially if there is any improvement in the German labour outlook.

The week's prices are appended :—

Soft foreign (prompt) : Thursday, £20 2s. 6d.; Friday, £20 1s. 3d.; Monday, £19 18s. 9d.; Tuesday, £19 17s. 6d.; Wednesday, £19 16s. 3d.

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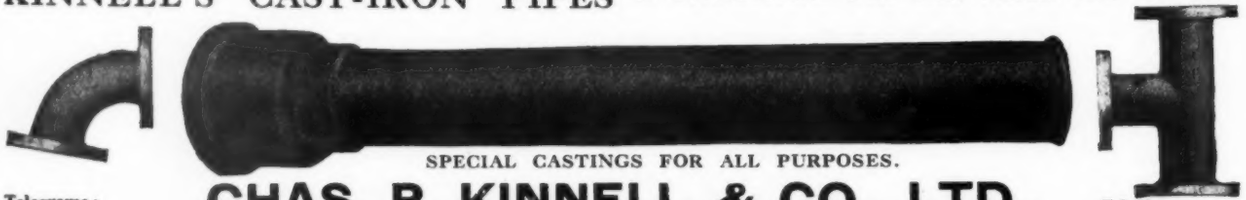
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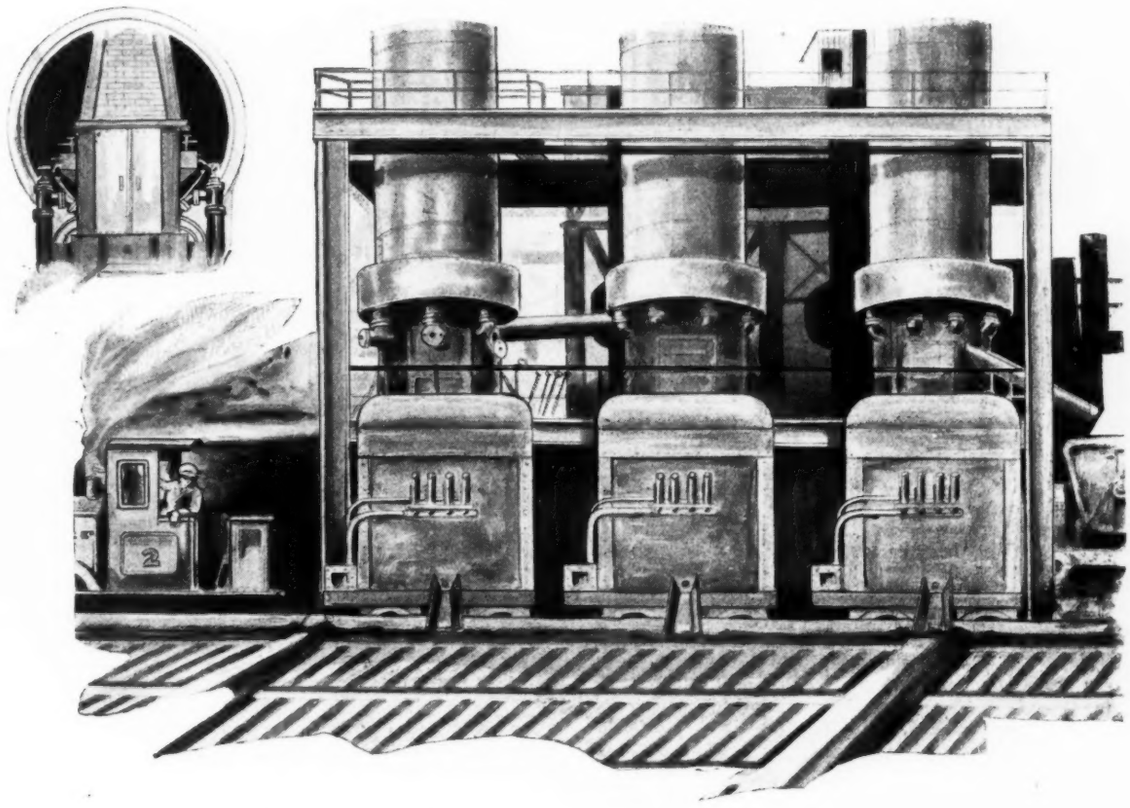
Telephone: Stockton-on-Tees 741 (two lines).



"A Quality for Every Requirement"

IN these days, when castings have to withstand very definite tests, it is essential that pig irons of a regular, reliable quality, and guaranteed analysis, be readily available.

Whatever your requirements may be, you will find a particular quality in the Bradley range of Refined Pig Irons that is just what you want—made for your specific purpose by up-to-date methods with plant under metallurgical control.

WRITE TO-DAY

Our booklet, giving full particulars of Bradley's Refined Pig Irons for every requirement, will be sent by return of post to all desirous of obtaining a copy.

Bradley's PIG IRON

BRADLEY & FOSTER LTD B&F DARLASTON, STAFFS.

WEEKLY PRICE CURRENT.

COPPER

	£	s.	d.
Standard cash	61	3	9
Three months	61	5	0
Electrolytic	66	10	0
Tough	64	5	0
Best selected	64	15	0
Sheets	92	0	0
India	76	0	0
Wire bars	66	15	0
Do. March	66	10	0
Do. April	61	12	6
Ingot bars	61	12	6
H.C. Wire rods	71	5	0
Off. av. cash, Jan.	61	18	11 1/32
Do. 3 mths., Jan.	61	15	0 31/32
Do., Sttlmnt., Jan.	61	18	10 9/16
Do., Electro, Jan.	66	16	1 7/16
Do., B.S., Jan.	66	4	8 3/8
Aver. spot price, copper, Jan.	61	18	11
Do., Wire bars, Jan.	67	1	1 1/4
Solid drawn tubes			13d.
Brazed tubes			13d.
Wire			9 1/2d.

BRASS.

Solid drawn tubes	11 3/4d.
Brazed tubes	13 3/4d.
Rods, drawn	10 3/4d.
Rods, extd. or rlld.	7 3/4d.
Sheets to 10 w.g.	10 1/4d
Wire	9 1/2d
Rolled metal	9 1/2d
Yellow metal rods	7 1/4d
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8 1/4d

TIN.

	£	s.	d.
Standard cash	225	0	0
Three months	227	5	0
English	230	5	0
Bars	231	10	0
Straits	228	10	0
Australian	227	10	0
Eastern	232	5	0
Banca	229	10	0
Off. av. cash, Jan.	253	6	5 1/32
Do., 3 mths., Jan.	252	5	1 1/16
Do., Sttlmt., Jan.	253	6	4 1/16
Aver. spot, Jan.	253	6	5

SPELTER.

Ordinary	25	5	0
Remelted	25	5	0
Hard	19	15	0
Electro 99.9	29	5	0
English	25	10	0
India	21	10	0
Zinc dust	33	0	0
Zinc ashes	8	0	0
Off. aver., Jan.	26	1	9 5/32
Aver., spot, Jan.	26	2	6

LEAD.

Soft foreign ppt.	19	16	3
English	21	5	0
Off. average, Jan.	21	19	10 1/32
Average spot, Jan.	21	15	5 1/2

ZINC SHEETS, &c.

Zinc sheets, English	33	10	0
Do. V.M. ex whf.	32	0	0
Rods	39	0	0
Boiler plates	29	10	0
Battery plates	31	5	0

ANTIMONY.

Special brands, Eng.	58	0	0
Chinese	43	10	0
Crude	35	0	0

QUICKSILVER.

Quicksilver	21	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—			
25%	8	2	6
45/50%	12	17	6
75%	20	10	0
Ferro-vanadium—			
35/40%	14/3 lb. va.		
Ferro-molybdenum—			
70/75% c. free	4/10 lb.		
Ferro-titanium—			
23/25% carbonless	11d.		
Ferro-phosphorus, 20/25%	£17	15	0
Ferro-tungsten—			
80/85%, c. fr.	1/3 lb.		
Tungsten metal powder—			
98/99%	1/7½ lb.		
Ferro-chrome—			
2/4% car.	£32	15	0
4/6% car.	£22	2	6
6/8% car.	£22	7	6
8/10% car.	£22	7	6
Ferro-chrome—			
Max. 2% car.	£35	0	0
Max. 1% car	£41	0	0
Max. 0.70% car	£50	0	0
70% carbonless	1/2 lb		
Nickel—99% cubes or pellets	£175	0	0
Ferro-cobalt	9/6 lb.		
Aluminium 98/99%	£105	0	0
Metallic chromium—			
96/98%	2/10 lb.		
Ferro-manganese (net)—			
76/80% loose	£13	10	0
76/80% packed	£14	10	0
76/80% export	£13	5	0
Metallic manganese—			
94/96% carbonless	1/10 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0	2	6
Finished bars, 18% tungsten	£0	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ½ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Hvy. steel					3	2	6
Bundled steel and shrngs.	2	16	0	to	3	0	0
Mixed iron and steel	2	15	0	to	2	16	6
Heavy cast iron	2	17	6	to	3	0	0
Good machinery for foundries	3	2	6	to	3	5	0
Cleveland—							
Heavy steel					2	15	0
Steel turnings					2	8	6
Cast iron borings					2	3	0
Heavy forge					3	10	0
Bushelled scrap					3	2	6
Cast-iron scrap	3	2	0	to	3	6	0
Lancashire—							
Cast-iron scrap					3	5	0
Hvy. wrought					3	2	6
Steel turnings					2	2	6

London—Merchants' buying prices delivered yard.

Copper (clean)	52	0	0
Brass (clean)	38	0	0
Lead (less usual draft)	17	10	0
Tea lead	15	10	0
Zinc	16	0	0
New aluminium cuttings	75	0	0
Braziery copper	47	0	0
Gunmetal	48	0	0
Hollow pewter	165	0	0
Shaped black pewter	125	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	70/-
Hematite M/Nos.	69/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	83/-
,, d/d Birm.	87/-
Midlands—	
Staffs. common*	—
,, No. 4 forge	62/6
,, No. 3 fdry.	64/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	—
,, fdry. No. 3	59/- to 60/-
Derbyshire forge	60/-
,, fdry. No. 3	64/- to 65/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	70/-
Hem. M/Nos.	73/6
Sheffield (d/d district)—	
Derby forge	61/6
,, fdry. No. 3	65/-
Lincs. forge	60/6
,, fdry. No. 3	65/-
E.C. hematite	82/6
W.C. hematite	85/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	72/3
Northants foundry No. 3	—
Dalzell, No. 3	100/- to 102/6
Summerlee, No. 3	87/6 to 94/-
Glengarnock, No. 3	87/6 to 94/-
Gartsherrie, No. 3	87/6 to 94/-
Monkland, No. 3	87/6 to 94/-
Coltness, No. 3	87/6 to 94/-
Shotts, No. 3	87/6 to 94/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.) nom.	9	5	0	to	10	10	0
Angles						—	
Tees to 3 united ins.						—	
Nut and bolt iron					9	0	0
Hoops					12	0	0
Marked bars (Staffs.) f.o.t.					12	10	0
Gas strip					12	0	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	7	6	to	8	12	6
Boiler plts.					10	10	0
Chequer plts.					10	5	0
Angles					7	17	6
Tees					8	17	6
Joists					7	17	6
Rounds and squares, 3 in. to 5½ in.					7	10	0
Rounds under 3 in. to ¾ in. (Untested)					7	15	0
					and upwards		
Flats, over 5 in. wide and up					8	17	6
Flats, 5 in. to 1½ in.					7	17	6
Rails, heavy	8	2	6	to	8	7	6
Fishplates					12	10	0
Hoops (Staffs.)					10	10	0
Black sheets, 24g.					10	2	6
Galv. cor. shts., 24g.					13	7	6
Galv. fencing wire 8g. plain					12	10	0
Billets, soft	£6	0	0	to	6	10	0
Billets, hard	£7	2	6	to	7	12	6
Sheet bars	£5	12	6	to	5	15	0
Tin bars	£5	12	6	to	5	15	0

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	2½
Sheet to 10 w.g.	1	3
Wire	1	3¾
Rods	1	3
Tubes	1	8½
Castings	1	2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.76
No. 2 foundry, Valley	17.25
No. 2 foundry, Birm.	16.00
Basic	18.76
Bessemer	19.26
Malleable	19.01
Grey forge	18.51
Ferro-mang. 80% d/d	100.00
Bess rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	44.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.90
Sheets, galv., No. 24	3.65
Sheets, blue an'l'd., 9 and 10	2.10
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplate, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	14/1½
Other Districts, foundry	—
,, ,, furnace (basis)	12/- to 13/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14	box	17/9	
,,	28×20	,,	35/6	
,,	20×10	,,	—	
,,	18¾×14	,,	—	
C.W.	20×14	,,	16/10½	
,,	28×20	,,	—	
,,	20×10	,,	—	
,,	18¾×14	,,	—	
Terneplates	28×20	—	per box basis f.o.b.	

SWEDISH IRON.

Bars, hammered, £17 10 0	to £18 10 0
Rolled Ord.	£15 0 0 to £15 10 0
Nail rods	£15 7 6 to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	£5 15 0 to

all f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	45%
Water	63¾%	40%
Steam	60%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
Mar. 8	61 2 6	inc. 5/-
,, 9	61 6 3	,, 3/9
,, 12	61 8 9	,, 2/6
,, 13	61 3 9	dec. 5/-
,, 14	61 3 9	No change

Electrolytic Copper.

	£ s. d.	
Mar. 8	66 10 0	No change
,, 9	66 10 0	,, ,,
,, 12	66 10 0	,, ,,
,, 13	66 10 0	,, ,,
,, 14	66 10 0	,, ,,

Standard Tin (cash).

	£ s. d.	
Mar. 8	230 2 6	dec. 2/6
,, 9	229 10 0	,, 12 6
,, 12	228 17 6	,, 12/6
,, 13	224 10 0	,, 87/6
,, 14	225 0 0	inc. 10/-

Tin (English ingots).

	£ s. d.	
Mar. 8	235 5 0	No change
,, 9	234 10 0	dec. 15/-
,, 12	234 0 0	,, 10/-
,, 13	229 10 0	,, 90/-
,, 14	230 5 0	inc. 15/-

Zinc Sheets (English).

	£ s. d.	
Mar. 8	34 0 0	dec. 20/-
,, 9	33 10 0	,, 10/-
,, 12	33 10 0	No change
,, 13	33 10 0	,, ,,
,, 14	33 10 0	,, ,,

Spelter (ordinary).

	£ s. d.	
Mar. 8	25 5 9	inc. 3/3
,, 9	25 10 0	,, 4/3
,, 12	25 7 6	dec. 2/6
,, 13	25 3 9	,, 3/9
,, 14	25 5 0	inc. 1/3

Lead (English).

	£ s. d.	
Mar. 8	21 10 0	inc. 5/-
,, 9	21 10 0	No change
,, 12	21 5 0	dec. 5/-
,, 13	21 5 0	No change
,, 14	21 5 0	,, ,,

Exports of Iron Castings in February and the two months 1928, compared with February and the two months 1927.

	February, 1927.	February, 1928.	Two months, 1927.	Two months, 1928.	February, 1927.	February, 1928.	Two months, 1927.	Two months, 1928.
BUILDERS' CASTINGS—								
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers:—	Tons.	Tons.	Tons.	Tons.	£	£	£	£
To Argentine Republic	102	122	277	308	3,574	5,764	9,101	13,046
,, British South Africa	175	277	494	785	6,865	9,789	18,505	26,488
,, ,, India	96	128	216	351	4,625	6,575	10,685	16,163
,, Australia	93	34	180	138	5,665	2,209	9,860	8,554
,, New Zealand	225	178	502	411	10,029	8,956	24,622	20,340
,, Other countries	637	647	1,480	1,575	31,915	31,177	73,107	72,891
Total	1,328	1,386	3,149	3,568	62,673	64,470	145,880	157,482
PIPES AND FITTINGS—CAST—								
To Argentine Republic	805	416	1,525	1,127	9,089	5,914	17,782	12,724
,, British South Africa	385	338	726	684	5,402	4,695	12,682	10,307
,, ,, India	421	580	652	1,055	6,079	8,412	9,925	16,277
,, Straits Settlements and Malay States	328	484	484	3,227	4,441	4,840	6,844	28,068
,, Ceylon	55	110	103	197	611	1,647	1,550	2,686
,, Australia	234	272	463	880	3,861	3,316	8,605	10,564
,, Other Countries	2,420	4,705	5,758	11,052	39,492	74,888	93,291	150,069
Total	4,648	6,905	9,711	18,222	68,975	103,712	150,679	230,695
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	410	402	826	708	15,215	14,446	31,974	26,305
,, Enamelled	47	71	130	148	4,610	6,501	12,363	12,813
CASTINGS, in the rough—								
Iron	117	125	302	214	3,771	4,648	10,076	8,080
Steel	18	34	99	95	1,035	1,335	5,690	4,366

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK
LIMPET

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
19, ST. VINCENT PLACE, GLASGOW.
ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

ADVERTISER, disengaged, with 20 years' experience as Foundry and Pattern Shop Manager, also Technical Representative with well-known firms in the Midlands, desires post in similar capacity.—Box 662, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER OR FOREMAN desires position; 20 years' experience in heavy and light, loam, dry sand and green sand, condensing plants, Uniflow and Diesel engines and machine tools; highest references.—Box 625, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN, accustomed up-to-date methods of repetition machine moulding; good opportunity for keen man who can organise and show results.—Write, Box 656, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

SENIOR ASSISTANT METALLURGIST required by large Engineering Works in the North of England; analysis of Brass, Bronze, Aluminium Alloys, Iron and Steel and raw materials used in their manufacture; experience in metallography essential.—Reply, stating age, experience and salary required, to Box 668, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WANTED.—Foundry Foreman in the London district; a good salary will be paid to a thoroughly competent man with good knowledge of light steel castings; state age, experience, and salary required.—Box 658, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY.

Three COVENTRY PATENT MOULDING MACHINES, to take standard moulding boxes (12 x 14 and 14 x 16); price £40 each.

Five No. 0 BRITANNIA JAR RAM MOULDING MACHINES, size of table 16-in. square, lift 6 in.; price £30 each.

One SAMUELSON TURNOVER MOULDING MACHINE, size of table 21 in. x 31 in.; price £25.

One PRESS MOULDING MACHINE (Samuelson); price £5.

One 6-in. x 7-ft. "WORCESTER" CENTRE LATHE, with change wheels; price £20.

One 3-SPINDLE "SELSON" VERTICAL GANG DRILL; price £15.

Two "ALFRED HERBERT" SEMI-AUTOMATIC TURRET LATHES; price £20 each.

All the above are in good working order.—Box 666, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

Two HYDRAULIC MOULDING MACHINES, by Bonvillain, for 21 in. dia. moulding box; adjustable head; admit up to 20 in. high from table.

One ditto; admit 30 in. high from table.

One WHEEL MOULDING MACHINE, by Buckley & Taylor, with table 6 ft. 3 in. diameter.

One similar with table 3 ft. 3 in. diameter.

One 16-ton Geared Foundry Ladle.

One 7½-ton Geared Foundry Ladle.

One 5½-ton Geared Foundry Ladle.

Immediate disposal; low price, etc., apply to Mr. Small,

J. MUSGRAVE & SONS, LTD.,
GLOBE IRONWORKS, BOLTON.
'Phone: 1832.

MACHINERY.—*Continued.*

BARGAIN.—Practically new Plant by Pneulec Company; only done two months' work.

Electrically-operated Jar Ram Moulding Machine, with motor, up to 12-cwt. castings.

P.M.-type Oil Sand Mixer, with hopper.

No. 4 Gas-fired Core Stove, with thermometers.

P.-type Tamper Moulding Machine.

Also Moulding Boxes for 12-ton new specification wagon axle boxes.

Core Plates and Boxes, etc.

Must be cleared.—Box 644, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

CUPOLA, with deep well, charging platform and blowing fan complete, wanted, to melt 30 cwt. per hour.—Full particulars to Box 664, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

30-CWT. CUPOLA, 3-ft. 6-in. outside dia. Tabor Rollover Moulding Machine. Mumford Squeezing ditto. Ton Geared Ladle, 2 ft. 6 in. x 2 ft. 3 in.—Box 660, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY PLANT, &c., FOR SALE.

DIAMOND Surface grinder, with Magnetic Chuck 2 ft. 8 in. x 10 in.

No. 14 BROWN & SHARPE External Cylinder Grinding Machine.

PRATT & WHITNEY 14-in. Vertical Surface Grinder.

PARKINSON No. 7A Sunderland Gear Generating Machine.

5-ton "Grafton" LOCO. STEAM CRANE, 35-ft. steel jib, all motions, 80-lbs. W.P.

5-ton "Rushworth" LOCO. STEAM SHUNTING CRANE, 26-ft. steel jib, all motions, 60-lbs. W.P.

Two dish-ended LANCASHIRE BOILERS, by Thompson, 30 ft. x 8 ft., reinsure for 150-lbs. per sq. in. working pressure.

Large stock of very good second-hand FLAT-ENDED CIRCULAR BOILER STORAGE TANKS.

CATALOGUE (10,000 Lots) ON APPLICATION.

THOS. W. WARD LTD.,
ALBION WORKS, SHEFFIELD

TENDERS.

FOR SALE.

The old-established Business of General Engineers, Iron and Brass Founders, Boilermakers and Ship Repairers, carried on at Dundalk, Ireland, by THE DUNDALK IRON WORKS (E. MANISTY & COMPANY), LIMITED (now in Voluntary Liquidation).

TENDERS are invited by the Liquidator for the purchase of the entire Undertaking of the Company, comprising the Goodwill of the Business, Premises, Plant and Machinery and Stock-in-Trade. The Works cover an area of approximately 38,000 square feet, and are only half a mile from the Great Northern Railway Station. The site is held for ever at an annual rent of £46 6s.

The Liquidator will, as an alternative, consider Tenders for the purchase in separate Lots of:—

Lot 1.—The Company's interest in the Site and Premises, which are suitable for any Firm requiring Factory accommodation in the neighbourhood.

Lot 2.—Plant and Machinery, including 2 Cupolas, 10 Lathes, Power Hammer, Drilling, Planing, Shaping and Slotting Machines, etc., and Engineers' Tools.

Lot 3.—Stock-in-Trade, consisting of a varied assortment of Foundry and Engineers' Stores.

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